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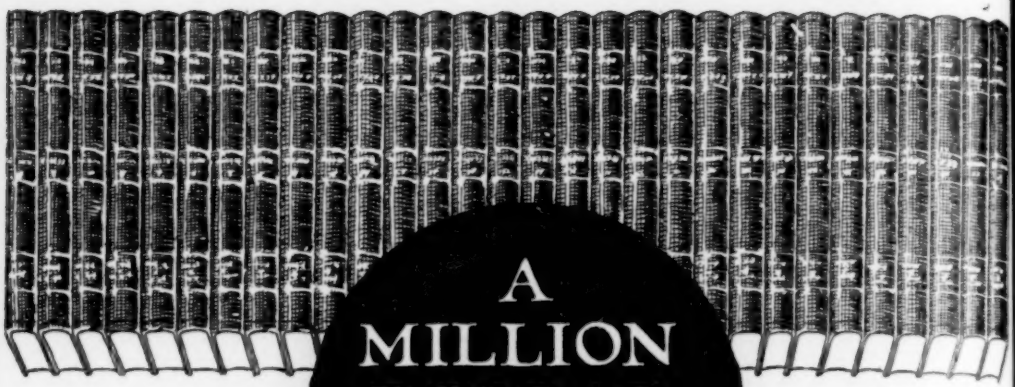

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THE SCIENTIFIC MONTHLY

MARCH, 1922

THE PROBLEMS OF THE TIDE

By H. A. MARMER

COAST AND GEODETIC SURVEY, DEPARTMENT OF COMMERCE

AS a phenomenon of every-day occurrence the regular rise and fall of the tide must have been noted early in the history of mankind. It so happens, however, that the maritime people of antiquity whose history has come down to us lived close to the shores of the Mediterranean Sea where the tide is very small. As a consequence, the tide received scant attention from these people, since it was of little importance in their every-day affairs, and the tidal knowledge possessed by them was not very extensive.

Not only did the maritime people of antiquity disregard the tide for practical purposes, but even as a subject of study and speculation tidal phenomena received little attention. In consequence of the small range of the tide in the Mediterranean the tidal phenomena were not very impressive, and the regularity of their occurrence was frequently masked by the disturbing effects of wind and atmospheric pressure. So far as biblical literature is concerned, there appears no direct reference to the tide either in the Old or New Testaments. And even in classical literature the passages dealing with tides are relatively few in number.

In common with the early explanations advanced for other physical phenomena, the earlier attempts at explaining the tides were based largely on fanciful notions. Some of the ancient philosophers believed the earth to be an animal; it therefore appeared entirely logical to ascribe the rise and fall of the tide to the breathing of this animal or to its drinking in and spouting out a certain portion of the water. Another explanation based on the same belief regarded the water as constituting the blood of the earth and the tide as the beating of its pulse.

With the growth of a more critical spirit more rational theories were advanced, and we find the tide ascribed to differences in the level of the sea, to the discharge of rivers into the sea, to whirlpools and eddies, and finally to sun and moon. Just how early the connection between moon and tide had been recognized we

do not know; we do however have record of the fact that Pytheas of Massilia who lived about 325 B. C., and who navigated the ocean from the Strait of Gibralter to the British Isles, noted a relationship existing between moon and tide.

When we come toward the end of the first century of the Christian era, we find the tides ascribed definitely to the action of sun and moon. In his Historia Naturalis, which appeared in the year 77 A. D., Pliny, the Elder, speaks of the tides in the following words:

> Much has been said about the nature of waters; but the most wonderful circumstance is the alternate flowing and ebbing of the tides, which exists, indeed, under various forms, but is caused by the sun and moon.

In succeeding passages, Pliny describes some of the principal phenomena of the tides. He is aware that there are two high and two low waters in a day; that the tides at any given place follow the moon's meridian passage by an approximately constant interval; that the extent of rise and fall varies with the changing phases of the moon, and that the tides are higher at the times of the sun's equinoxes than at the solstices. He does not however advance any explanation for the relationship of moon and tide except that in the concluding passage of the section devoted to tides he says:

> Hence we may certainly conjecture, that the moon is not unjustly regarded as the star of our life. This it is that replenishes the earth; when she approaches it, she fills all bodies, while when she recedes, she empties them. From this cause it is that shell-fish grow with her increase, and that those animals which are without blood more particularly experience her influence; also, that the blood of man is increased or diminished in proportion to the quantity of her light; also, that the leaves and vegetables generally, as I shall describe in the proper place, feel her influence, her power penetrating all things.

That the tide is brought about by the combined action of sun and moon, Pliny definitely states; but he likewise definitely ascribes the leading rôle to the moon. The early formulation of the problem of the tide may therefore be stated as follows: The moon governs the rising and falling of the surface of the sea; how does the moon do this?

Progress to the Time of Newton

This problem of the agency by means of which the moon exerts its influence on the waters of the earth appears to have engaged the attention of many of the leading philosophers in the centuries following Pliny. Thus at the beginning of the eighth century, some six hundred years after Pliny, we find the noted English scholar, the Venerable Bede, devoting to the tides a chapter in his De Temporum Ratione. And while on the English coast the tide is a much more impressive phenomenon than on the shores of the

Mediterranean, there appears no progress in Bede's remarks toward a solution of the problem of the tide.

Indeed, virtually no progress can be recorded for sixteen hundred years following the time of Pliny. While we find Kepler and others attributing the tides to an attractive force of the moon analogous to magnetic attraction, there were not wanting others, among whom must be mentioned Gallileo, who contended that the idea of the moon being the principal cause of the tides was preposterous. The state of knowledge regarding the tide about the middle of the seventeenth century is well summarized in the Geographia Generalis of Bernhardus Varenius which appeared in 1650. The following quotation is from an English translation by Dugdale in 1733:

> There is no Phænomenon in Nature that has so much exercised and puzzled the Wits of Philosophers and learned Men as this. Some have thought the Earth and Sea to be a living Creature, which, by its Respiration, causeth this ebbing and flowing. Others imagined that it proceeds, and is provoked, from a great Whirlpool near Norway, which, for Six Hours, absorbs the Water, and afterwards, disgorges it in the same space of Time. Scaliger, and others, supposed that it is caused by the opposite Shores, especially of America, whereby the general Motion of the Sea is obstructed and reverberated. But most Philosophers, who have observed the Harmony that these Tides have with the Moon, have given their Opinion, that they are entirely owing to the Influence of that Luminary. But the Question is, what is this Influence? To which they only answer, that it is an occult Quality, or Sympathy, whereby the Moon attracts all moist Bodies. But these are only Words, and signify no more than that the Moon does it by some means or other, but they do not know how: Which is the Thing we want.

Newton's Contribution

With the discovery of the law of gravitation by Newton, the connection between moon and tide received a rational explanation. In his Principia, which appeared in 1687, Newton proved that the tides were a necessary consequence of the law of gravitation. The sun and moon in their varying positions relative to the earth bring about attractive forces which, with regard to the solid earth and the overlying waters, are unequal. And it is these differences of attraction which give rise to the tides.

Newton treated the problem as a static one. Simplifying matters by supposing the sea to cover the whole earth and to assume at each instant a surface of equilibrium, he was able to deduce the principal phenomena of the tides in terms of the theory of gravitation. Thus, from this method of treatment it followed that two high and two low waters should occur each day and that the range of the tide should be greatest about the times of new and full moon and least when the moon was in quadrature. Furthermore, morning and afternoon tides should be unequal except when the sun and moon are in the plane of the equator.

Having shown the adequacy of the theory of gravitation to account for the principal phenomena of the tides, Newton did not push his investigations further, but left the development of the theory of the tides to subsequent investigators. And it appeared, at first, as if the problem of the tide were nearing a complete solution.

But it soon became evident that Newton's theory of the tide could not be made to explain a number of important features. On the assumption of the surface of the sea being a surface of equilibrium in response to the tide-producing forces of sun and moon, the range of the tide should not be over three feet, and should vary from the equator to the poles. As we actually find the tide in nature, however, the rise and fall varies from less than a foot to more than forty feet, but without the slightest relation to latitude. Furthermore, according to this theory, the daily inequality in the tides, that is, the inequality in the two high or two low waters of a day, should be zero at the equator and very considerable in the higher latitudes. Yet we find this inequality quite negligible on the coasts of Europe and very marked in the equatorial regions of the Pacific.

There are other features of the tide which this theory leaves unexplained. In fact, the basis of this static theory is in one respect completely at variance with the actual condition of things, for the surface of the sea in response to the tide-producing forces does not even approximate toward a surface of equilibrium. Nevertheless, this theory of the tide, as formulated by Newton, furnished the foundation on which all subsequent work was based; and in the hands of Daniel Bernoulli (1700-1782) this static theory, known as the Equilibrium Theory, was developed sufficiently to give it practical value in the prediction of tides for any particular port when based on tidal observations made at that port.

It may be of interest to note here that in 1738—some fifty years after Newton's formulation of the law of gravitation—the Académie des Sciences at Paris proposed the problem of the tides as the subject of a prize essay. Two years later this prize was divided among four contestants: Daniel Bernoulli, professor of anatomy and botany at Basel; Colin Maclaurin, professor of mathematics at Edinburgh; Leonard Euler, professor of mathematics at St. Petersburg and the Jesuit Antoine Cavalleri. The three first mentioned based their essays on the principle of gravitation and on Newton's theory of the tide, but Cavalleri based his on Descartes' theory of vortices. This appears to have been the last honor paid to Descartes' theory which had already been abandoned by most philosophers in favor of Newton's more rational theory.

With the discovery of the law of gravitation, the formulation of the problem of the tide became somewhat changed, for it was now no longer a question as to the agency by means of which the moon controlled the tide. The problem now resolved itself to deriving a formula which would express completely the relation between the rise and fall of the sea and the tide-producing forces brought about by the gravitational attraction of moon and sun. This, as we found, Newton's static theory of the tide did not accomplish.

The Dynamic Theory

Toward the close of his prize essay on the tides, Euler attempted to treat the problem as one of fluid motion. However, the equation he derived to express the tidal conditions is regarded as not expressing the true tidal conditions, but merely somewhat analogous ones. And it is to Laplace that we must credit the first attempt at a solution of the tidal problem as one of fluid motion. In other words, he approached the problem from the standpoint of dynamics and his theory is known as the dynamic theory of the tides.

Laplace's theory of the tides is contained in his Mécanique Céleste, and his contribution has been of profound importance in the development of the subject. He determined the fundamental tidal equations and expressed the tide-producing forces in the form of the potential, from which the actual forces upon any point of the ocean can readily be obtained. He showed further that these forces could be put in the form of a trigonometric series in which the angle varied with the time. But the solution of the equations resulting from the dynamic theory, after introducing the complex conditions of the existing oceans, either surpasses the power of analysis or entails such enormous labors as to be practically impossible. So that Laplace's theory, although very profound, does not succeed in expressing by means of a formula the rise and fall of the tide as we actually find it in nature.

A different approach to the dynamic solution of the problem was made by Airy, who treated the rise and fall of the tide as the movement of waves in canals. While expressly stating that this theory was imperfect, since this mode of treatment would not apply to every part of the ocean, he nevertheless derived a number of important results which serve to explain many of the observed phenomena of the tides in rivers and channels to which none of Laplace's results is strictly applicable.

Following Airy, a number of eminent mathematicians—Ferrel and Harris in America; Stokes, Kelvin, Darwin, Rayleigh, Lamb and Hough in Great Britain; Lévy and Poincaré in France; Börgen in Germany—have added to the further development of the theory

of the tides, either by dealing with the matter directly or by investigating some of the mathematical and physical questions involved. In the meantime there had also occurred a very notable increase in our knowledge of the geographical distribution of the tides brought about, in part, by the use of the automatic tide gauge for securing continuous observations over a considerable period of time.

SUBSTITUTION OF "PROBLEMS" FOR "THE PROBLEM"

With the extension of our knowledge of the rise and fall of the tide as it actually takes place in the various oceans, it became evident that the use of a simple mathematical formula to express the phenomenon was becoming increasingly difficult. For the coordination of the material at hand necessitated such an overloading with corrections of the simpler formulæ previously in use that the unity and simplicity assumed became altogether fictitious.

There thus came to be a tacit recognition of the fact that instead of being confronted with a problem of the tide, the phenomenon involves a number of problems. In other words, the tides as they manifest themselves in the various oceans constitute, not a single phenomenon, but a number of phenomena united only by the bond of a common sustaining force in the gravitational action of sun and moon.

The earliest formulation of the problem of the tide involved the determination of the agency whereby the moon controlled the tide. With the announcement of the law of gravitation, the problem shifted to deriving a mathematical formula to express completely the rise and fall of the tide at any point in response to the tide-producing forces of sun and moon, this involving the assumption that the tide represents a world phenomenon. Now we come to a further shift in the recognition that the phenomena of the tides as we find them in nature involve a number of problems. As matters stand now we may formulate the problems of the tide as follows: Given the tide-producing forces of sun and moon and the form, size, depth and location of an ocean basin or other body of water; required the resulting tidal phenomena.

It is to be noted that in the present formulation of the old "problem of the tide" there is a tacit recognition of the fact that the tide may not constitute a single world phenomenon, and that the tides in any given ocean basin may be independent, to a very large extent, of the tides in the other oceans. This change of view resulted directly from the increased knowledge of the behavior of the tides at various places. The tides of the north Atlantic were the ones with which the first investigators were familiar, and the ones with which they compared their theories. The tides of the

Pacific were found to be considerably different, and the tides in the Gulf of Mexico differed still further. And as accurate observations for the lesser known regions increased, further differences in the tides were brought to light.

This increase in the store of accurate information regarding the tides of the seven seas, while disastrous to the elegance of the solution of the problem of the tide, permitted a mechanical conception of the movement of the tide. By a synthesis of the results of these widely scattered tidal observations it had become possible to construct a theory, based on the observed times and heights of the tide, as to the mechanism whereby the tides along the various coasts are brought about by the tide-producing forces of sun and moon.

Whewell's Progressive Wave Theory

In 1833 William Whewell presented before the Royal Society of London a memoir entitled "Essay Towards a First Approximation to a Map of Cotidal Lines." Included in this memoir was a map of the world on which were drawn so-called cotidal lines, that is, lines joining points at which high water occurs at the same time. On this cotidal map, the tide is shown progressing from south to north in the Atlantic, Pacific and Indian Oceans, while in the Southern Ocean, the belt of water that completely encircles the globe southward of the great land masses, the tide is shown as progressing westward.

It is to be remembered that tidal observations have been confined almost without exception to the immediate vicinity of the coast, and that over the wide expanses of the open ocean the time of high water is not known from direct observations. The joining by a cotidal line of two points separated by a wide expanse of water, can only be made in accordance with certain assumptions, and the entire character of a cotidal map depends on these assumptions. Whewell expressly emphasized this by stating in his conclusion to the memoir "I shall be neither surprised nor mortified if the lines which I have drawn shall turn out to be in many instances widely erroneous: I offer them only as the simplest mode which I can now discover of grouping the facts which we possess."

The name of Whewell and also that of Sir John Lubbock (1803-1865) should have been included in the list of those whose work contributed considerably to the advancement of our tidal knowledge. Dealing largely with observational results these two investigators analyzed and coordinated enormous masses of tidal data at various ports. And it was at Whewell's suggestion that in 1835 the United States and several European countries cooperated in securing simultaneous tidal observations covering a period of about three weeks at a number of points.

As represented by Whewell the tide has its origin in the Southern Ocean. Here, it was argued, the tidal forces have almost uninterrupted sway and the moon in its journey around the earth compels the tide in this ocean to keep time with its own motion. And it is from this tide wave, which is constrained to keep step with the moon, that tides are propagated to the north through the three great channels of the Atlantic, Pacific and Indian Oceans.

Whewell's progressive wave theory, or, as it is frequently called, the Southern Ocean theory, therefore sets up the forced tide wave in the Southern Ocean as dominating the tides of the world. From this primary forced tide wave, progressive waves set northward through the various oceans at a rate dependent on the depth of the tidal waterway. And the differences in the times, ranges and types of the tide are accounted for as being due to differences in depth and width of channel, to changes in the configuration of the shore line and to interferences of tide waves coming from different directions.

This progressive wave theory has many things in its favor: it is very plausible and explains certain features of the tides as they are found in nature. And it has had many distinguished proponents, notably Sir George Darwin, son of the great Darwin and himself a mathematician of the highest rank. To quote Darwin, "It is interesting to reflect that our tides to-day depend even more on what occurred yesterday or the day before in the Southern Pacific and Indian Oceans than on the direct action of the moon to-day."

Too many of the characteristics of the tides however, are left by the progressive wave theory to be explained by changes in cross section of channel, configuration of coast line and by interferences of tide waves coming from different directions. Moreover, a number of investigators had from time to time suggested stationary waves or oceanic oscillation as a probable explanation of the very considerable rise and fall of the tide at many places on the open coast. And at the beginning of the present century the stationary wave was made the basis of a new theory of the tide.

Harris' Stationary Wave Theory

This newer theory is diametrically opposed to the ideas advanced by the Southern Ocean theory of the making of the tide. It does away with the conception of a single world phenomenon and substitutes regional oscillating areas as the origin of the dominant tides of the various oceans. It may be of interest to note here that the older theory is due to European mathematicians and tidal workers, while the newer theory is the outgrowth of American genius. Almost entirely, the stationary wave theory is the work

of one man, the late R. A. Harris of the United States Coast and Geodetic Survey. Before taking up this newer theory, it will be of advantage to digress for a moment to a consideration of progressive and stationary waves.

Along the coast we are familiar with the waves that come in from the ocean, the crests of which progress uniformly from point to point. If for the moment we call the crest of such a wave high water and its trough low water, it is evident that when this wave travels over a body of water, the times of high and low water will progress uniformly from one end to the other of the body of water. This kind of wave is known as a progressive wave, and such a wave travels with a speed depending on the depth of water.

A wave of a totally different kind may also be made to travel through a body of water. Suppose we have a vessel, say a rectangular tank, partly filled with water. If we raise and then immediately lower one end, a wave will be started which puts into oscillation the whole body of water. But it will be noticed that high water will occur at one end when it is low water at the other end, and that for the body of water as a whole, high water will occur simultaneously for one half at the same instant that it is low water for the other half. This type of wave is known as a stationary wave.

If we start stationary waves in tanks of various lengths filled with water to different depths, we will find that the time taken for a wave to travel from one end to the other and back, or the period of the wave, depends only on the length of the tank and the depth of the water. And if it is desired to maintain a wave of this kind in a tank, it is only necessary to apply a slight force to the tank at regular intervals; but it will be found that if this force is applied at intervals that coincide with the period of the wave we will have the maximum results.

Now to come back to the tides, the Stationary Wave theory states that the dominant tides of the world are caused by stationary waves which are set up and maintained in various portions of the oceans by the periodic tidal forces of sun and moon. According to this theory therefore, the tides do not constitute a general world phenomenon, but are local phenomena, the tides of any given region being due primarily to the stationary wave oscillation of that region.

The principal tidal forces of sun and moon have a period of about half a day. A stationary wave of the same period, in the deep waters of the ocean, has a length of approximately five thousand miles. On a map of the world that shows soundings we can therefore locate regions which have the requisite lengths and depths to support a stationary wave having the same period as the prin-

cipal tidal forces. Dr. Harris has done this and has outlined the systems of oscillating areas for the various oceans; and furthermore, by theoretical considerations, he has connected the phases of oscillation of these systems with the phases of the tide-producing forces.

The stationary wave theory thus makes of the tides of any given body of water a separate and distinct problem. If the body of water is small and sufficiently deep, we shall have equilibrium tides, that is, the surface will arrange itself normal to the direction of terrestrial gravity as disturbed by moon and sun. If the body of water is situated along the coast, the tide may be due either to a progressive wave from an oscillating system of the open sea or to a dependent stationary wave excited in the body of water itself. But in the open ocean the dominant tide is due to a stationary wave oscillation brought about by the tide-producing forces of sun and moon acting upon such portions of the ocean basin as are susceptible of sustaining stationary waves having the same period as the tide-producing forces.

It was unfortunate for the stationary wave theory that at its birth it met with adverse criticism at the hands of Sir George Darwin, who dissented absolutely from the views advanced by Harris. In his well known book on The Tides and Kindred Phenomena in the Solar System, Darwin further disparaged this feature of Harris's work by stating that "One cannot but admire his courage in attacking so formidable a problem; but I do not propose to explain his conclusions because I cannot bring myself to believe in the trustworthiness of the principles on which he relies."

Darwin's adverse criticism, in view of his well-deserved reputation as an authority on tidal matters, together with the weight carried by the name of Darwin, resulted in bringing Harris' theory into disfavor in Europe for some time. But in 1910 there appeared the third volume of Poincaré's Leçons de Mécanique Céleste in which after subjecting the various tidal theories to searching analysis, the great master states "Il est vraisemblable que la théorie définitive devra emprunter à celle de Harris, une part notable de ses grandes lignes." Due to Poincaré's exposition of Harris' work and also to the ease with which a number of otherwise baffling questions can be answered by the aid of the stationary wave theory, recent tidal researches have come more and more to be based on this newer theory of the tide.

The Prediction of Tides

In the development of the theory of tides, a number of interesting collateral problems have been brought to light. As examples we may mention the determination of the mass of the moon

from the observed heights of the tide; the prediction of the times and heights of high and low water; the determination of the rigidity of the earth from tidal observations; the effects of tidal friction; the variations in mean sea level. Even the briefest discussion of these collateral problems would not be possible in the present paper and we shall therefore limit ourselves to summarizing the work on two of these problems, namely, the prediction of tides and the effects of tidal friction.

An advance knowledge of the times and heights of high and low water is obviously of considerable importance to the mariner in entering or leaving a harbor; and the practical value of such knowledge led, early, to the prediction of tides for the construction of tide tables. It may perhaps be of interest to note here that the oldest tide table of which there is record is one now in the library of the British Museum. It is a manuscript table that appears to have been written in the thirteenth century, and gives the time of "flod at london brigge," that is, the time of high water at London Bridge. The time of high water as shown in this old tide table is made to increase by a constant difference of 48 minutes from day to day and is given not for calendar days of the month, but only with reference to the age of the moon.

To predict the tides two different methods have been employed. The older one, technically known as the nonharmonic method, is based on the close relationship existing between the time of high or low water at any given place and the moon's meridian passage. It begins by determining, from tidal observations made at the port for which predictions are desired, the time intervals elapsing between the moon's meridian passage and the occurrence of high and low water. These time intervals, known respectively as the high-water and low-water lunitidal intervals, have an approximately constant value for any given place and after having been once determined from a month or more of observations, may be used for making a rough tide table for that place by adding to the times of the moon's meridian passage as given in a nautical almanac.

As stated above, the lunitidal intervals for any given place are only approximately constant. During a lunar month they undergo periodic changes, depending principally on the variations in phase and declination of the moon. From long series of tidal observations these periodic changes may be determined, and by using these as corrections to the lunitidal intervals, satisfactory predictions of the times of high and low water may be secured. And for many years the tide tables issued in the various countries were constructed substantially as here outlined.

The height of the tide was predicted in a similar manner. The average heights of high and low water at the port for which pre-

dictions were desired were determined from observations. To these average heights there were then applied corrections for changes in the phase and parallax of the moon, these corrections likewise being derived from observations. And the tide tables produced by this method worked quite satisfactorily for Europe and for the Atlantic coast of the United States, where the tide is of a simple type. But when the nonharmonic method is used for the prediction of tides of a more complex type, such as found on the shores washed by the Pacific and Indian Oceans, it necessitates so many corrections as to become prohibitive. Before the need for accurate tide tables covering the whole maritime world became pressing, the mathematician had introduced a more powerful method for the prediction of tides, known as the harmonic method.

In the harmonic method the tide is conceived as being made up of a number of simple harmonic waves, each of which may be referred to some motion of sun or moon. In other words for sun and moon as tide-producing agencies this method substitutes a number of hypothetical tide-producing bodies which, with respect to the earth, have circular orbits in the plane of the equator. Each of these simple tide-producing bodies is assumed to give rise to a tide of its own kind, and the tide as it actually occurs in nature is thus considered as being made up of a number of simple harmonic tide waves each of which has a period corresponding to the period of its particular hypothetical tidal body.

The periods of revolution of the assumed tidal bodies and hence the periods of the simple constituent tides, are determined once for all from the known motions of sun and moon. These periods being independent of local conditions are therefore the same all over the earth; what remains to be determined for the various simple constituent tides is their phases and amplitudes which vary from place to place and which can be determined accurately only from observations. The mathematical process by which these phases and amplitudes are disentangled from the tidal observations at any place is a very ingenious one known as the harmonic analysis and is due to that versatile British mathematician, William Thomson, better known as Lord Kelvin, who first proposed it in 1867. Since that time the harmonic analysis has been extended and perfected chiefly by Darwin, Ferrel and Harris.

Now it is obvious that when the period, phase and amplitude of a simple harmonic constituent tide is known, it is not a difficult matter to find the height of the tide due to that constituent at any given future time. To predict, therefore, the tide that will actually occur at some future time, it is only necessary to add together the heights of the constituent tides at that time. The labor involved in doing this by ordinary methods of computation, however, is so

great as to be prohibitive, and it was only after Lord Kelvin had devised a machine which mechanically effects the summation of all the various tidal components, that the prediction of tides by the harmonic method was put on a practical basis.

Since Kelvin's first tide predictor, made in 1872, there have been introduced improved mechanical tide predictors, notably two devised in the U. S. Coast and Geodetic Survey, the earlier one in 1883 and the later one in 1910. In the tide tables for our own country, issued annually in advance by the Coast and Geodetic Survey, all the predictions are made by means of the mechanical tide predictor and this is also true to a large extent of the tide tables published by the other leading maritime nations. And the accuracy of these predictions as determined by comparison with the actual times and heights of the tide is all that one can expect in view of the disturbing influences of wind and weather. The problem of the prediction of tides, in so far as this is based on previous observations made at any given port, may therefore be considered as completely solved.

The Effects of Tidal Friction

In the motion of the waters brought about by the tides, friction is produced by the movements of the water particles against each other, by the movement of the water over the beds of seas and rivers and by the movement of the water on the shelving shores along the coast. There is, furthermore, friction produced in the yielding of the solid earth to the tide-producing forces of sun and moon. This tidal friction consumes energy which can come only from the rotational energy of the earth. In other words, tidal friction acts as a sort of brake on the rotating earth, tending to reduce its rotational velocity and as a consequence tending to make the day longer. The stock of energy possessed by the earth, however, is so enormously great as compared with the friction produced by the tides that it is only by a minute quantity that the day is lengthened by tidal friction even over a period of years. And while attempts at an accurate numerical estimate of the amount of this lengthening of the day has thus far been unsuccessful it appears probable that it is of the order of something like the thousandth part of a second in a century.

The effect of tidal friction is not confined to the earth alone, but makes itself felt on the moon. A mathematical investigation proves that besides decreasing the rotational velocity of the earth, tidal friction also tends to increase the period of revolution of the moon and to increase the distance between earth and moon. All these effects of tidal friction are exceedingly small now, but they have been operating for untold ages, so that by this time the cumulative effect must be considerable.

With these conclusions as to the effects of tidal friction, suppose we go backward in time and attempt to trace the early history of the earth and moon. Let us go so far back that the whole life of man on this earth is but a day in the reckoning, back to the time when according to the nebular hypothesis our earth was a molten mass. As we travel backward through time we are undoing the effects of tidal friction and the day is becoming shorter, the moon is approaching nearer the earth and the month is becoming shorter.

But it is to be noted that when the moon was nearer the earth the tides raised were much greater than now, for the tide-producing power of a heavenly body varies inversely as the cube of its distance from the earth. And aside from the increased friction due to the greater tides, the tidal friction varies inversely as the cube of the moon's distance from the earth. Hence the efficiency of tidal friction in increasing the length of day and month and the distance between earth and moon varies inversely as the sixth power of that distance. So that when the moon was one tenth her present distance from the earth, the effects of tidal friction were one million times as great as they are now. It follows therefore that although the effects of tidal friction now are excessively small, they were enormously greater in the remote past when the moon was nearer the earth.

Based on considerations as outlined above, Sir George Darwin has investigated the subject mathematically and developed an exceedingly interesting and very plausible theory as to the early history of earth and moon, from which it appears probable that the moon was at one time part of our earth.

The effect of tidal friction is to make both the day and month longer, but the increase in the length of the day is greater than the increase in the length of the month. It follows therefore, disregarding any counteracting influences that may intervene, that a time will come in the distant future when the day and the month will be of the same length. At this time moon and earth will be presenting the same faces to each other all the time and the moon will have ceased producing any tides on the earth, although the sun will still bring about a rise and fall of the surface of the sea.

The above is but a very meagre outline of this exceedingly interesting problem. But taken with what precedes it is probably sufficient to indicate the nature of some of the problems of the tide. Prior to the formulation of the law of gravitation, the study of the tide had engaged the attention of the leading philosophers; and since Newton's time many distinguished mathematicians have contributed to its development. It still constitutes a fertile field for research, offering to the investigator a number of interesting problems.

THE ORGANISM AND ITS ENVIRONMENT

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THERE are times when we need to remind ourselves that the organism—the real organism, which lives and grows, and functions and acts, and in some cases thinks—is not an isolated phenomenon in nature, but is part of a complex system of interacting forces. It is utterly unintelligible, indeed we shall see presently that it does not even exist, except in organic relation to the outer world. Nevertheless, various trends in present-day biological discovery and speculation have confirmed us in the habit of viewing the living being as a distinct and independent entity, and of underrating the importance of a thorough knowledge of its environmental relations. Add to this the inevitable increase of specialization in all fields of science, which has tended to separate and to keep apart those whose studies relate chiefly to the isolated organism from those who are concerned primarily with its conditions of life and occurrence in nature. It is possible that these tendencies have already passed their zenith, and that the movement toward a greater measure of integration in biology is making satisfactory headway. But a perusal of the writings of those who form the dominant groups at the present time does not furnish much ground for this belief.

Let me be somewhat more concrete in regard to the causes which have led to this relative neglect of the environment by modern biologists. Morphology has for years, and perhaps unavoidably, confined itself to the study of preserved organisms, or more frequently of the excised organs or tissues of organisms.

Physiology—when it has broken away from medical bondage and asserted its rights as an independent science—has commonly studied the activities of animals or plants, or isolated parts thereof, under strictly "controlled," *i. e.*, highly unnatural conditions. Taxonomy has dealt with collections of stuffed, pickled, pressed or otherwise preserved material. There has frequently been a rigid division of labor between the collector, who gathers and preserves the specimens, and observes them in nature, and the systematist, who studies and classifies them in his laboratory or museum, without such clues as are afforded by a knowledge of their local distribution, seasonal occurrence, life history, etc.

When we come to my own special field of genetics, this apotheosis of the organism and relative neglect of environmental factors is particularly evident. Strictly speaking, it is not even the organism here which is exalted into this position of well-nigh exclusive interest. It is that more or less imaginary entity, the "germ-plasm," which is conceived to flow on through the ages as an uninterrupted "stream," giving rise, at intervals, to ephemeral and relatively unimportant objects, the bodies of the individual organisms. Within broad limits, this "germ-plasm" is not supposed to be affected by the environment at all. It may, it is true, be killed by lack of food, extremes of temperature, or the like, or a particular "stream" of germ-plasm may at any time be brought to an untimely end by its failure to produce individuals which are adapted to their special conditions of life. But, aside from this process of selective elimination, the environment is not credited with the power of calling forth adaptive changes of a hereditary nature. Furthermore, many biologists are at present dubious as to whether environmental influences are capable of producing germinal changes of any sort, even those which result in the "mutations" upon which selection is supposed to act.

The great volume and the high importance of researches in Mendelian heredity during the past two decades have lead to a virtual identification of genetics with Mendelism. This statement applies not only to the rather confused notions of the layman, but to the deliberate utterances of the expert, who sometimes explicitly defines the word genetics in this restricted sense. Now Mendelism, as we all know, is concerned with the mode of transmission of certain more or less distinguishable "unit-characters" of the organism. These last, in turn, are supposed to be the visible manifestations of independent, indivisible, and in a high degree unalterable "factors" in the germinal substance. Occasional instances are cited, to be sure, in which particular unit characters depend for their manifestation upon particular conditions of the environment, and certain geneticists believe—usually as an article of faith—that unit factors may undergo "mutation" as the result of sufficiently potent changes in the external conditions. But, on the whole, the general effect of Mendelian studies has been to emphasize the isolation and independence of the organism—or at least, of its unit factors—and to minimize the importance of the environment, except as imposing limiting conditions to existence or growth.

After more than a generation of stalwart drubbing, Lamarckism is believed by most biologists to have yielded to the inevitable and to have gone to its last repose in an unhallowed grave. Not

only are individual acquirements believed to be incapable of hereditary transmission, but for man, at least, the rôle of external circumstances in the development of both body and mind, during the single lifetime, is frequently denied any very high importance. Environment—the "culture medium"—must furnish a certain low minimum of requirements for normal development. Beyond that, it is impotent to alter the preordained course of the individual life history.

The foregoing picture is not intended primarily as an indictment of recent biological philosophy. My chief object has been to point out some of the reasons for the relative neglect of the natural environment as an object of biological research. That the prevailing viewpoint which I have outlined above, is largely founded upon exact knowledge must, I believe, be admitted. That it represents an extreme position, and overlooks important lines of evidence, is to some of us equally clear. While I can not here enter into an extended justification of this last contention, I feel bound to indicate rather briefly the sort of facts upon which it is based.

In the first place, one can not overlook the utter bankruptcy of the Mendelian-Mutation scheme of things to account for evolution, and particularly to account for the origin of adaptive structures and functions.[1] Hereditary differences among organisms, according to this theory, depend upon the presence, in their respective "germ-plasms," of somewhat different unit factors. Every natural species and most artificial races are known to be far from homogeneous in their hereditary make-up. As the result of selection—natural or artificial—individuals carrying certain favorable factor combinations may be perpetuated to the exclusion of others. As long as this process of sorting out is possible, the average character of the race may be altered in one direction or another. Sooner or later, however, we reach a condition in which all members of our selected strain possess the particular factor combination that insures the highest possible manifestation of the character for which we are selecting. In respect to these particular factors, our material has become homogeneous, and further progress along this line must cease.

Now, as a matter of fact, we all know that in some cases such progress has been continued indefinitely. We may point to abundant instances from nature, in which a tendency, once started, has been continued throughout ages of geologic time. The reduction

[1] One prominent geneticist, Heribert-Nilsson, when confronted with the contradiction between the "facts" of Mendelism and the "theory" of evolution, escapes from his dilemma by casting the latter overboard! (Festkrift Lunds Universitet, 1918).

of the lateral toes of the horse's foot is an often cited example, which is as good as any. Certain breeding experiments, likewise, have shown the possibility of continuous modification throughout many generations. In some instances, this has occurred among the cultures of those who insist most strongly upon the truth of the "sorting out" conception of selection. Occasionally, too, there seems to be a sudden revival of the efficacy of the selective process, some generations after stability seemed to have been reached.

We are all familiar with the current explanation of these phenomena. Effective selection, in a race which has become homogeneous in respect to the factors concerned, is only possible through the occurrence of "mutations" or spontaneous changes in these factors. If such changes chance to occur in the same direction as the changes which were initiated by our selective process, the latter is given a new lease of life, until a condition of racial uniformity is once more established.

It is well to consider for a moment where such a conception leads us. There would seem to be nothing particularly mysterious in the fact that a race of organisms should undergo continuous changes in a given direction, as the result of "mutations," arising without any reference to environmental needs. Progressive changes are going on all about us in the inorganic world, some of these continuing for untold periods of time. What does need explaining is the fact that these changes, in the organic world, are so often in the direction of increasing adjustment to the conditions of life. Darwin's explanation of this fact—one which he felt obliged to supplement by another quite different explanation—is known to us as the theory of natural selection.

At the present day, there are probably as many estimates of the effectiveness of natural selection as there are biologists who are competent to express an opinion on the subject. All are probably agreed that it must be regarded as one of the factors of evolution. But most recent biologists are strongly impressed by various considerations which were either unknown to Darwin or were probably not sufficiently recognized by him. In the time allotted I can speak of only one of these. This is the inadequate supply of variations which are actually available as material for selection. At a time when most individual differences were believed to be more or less hereditary, and when practically no bounds had been set to the efficacy of the selection, it was much easier to assert the "all sufficiency" of this principle as the cause of progressive evolution. Even then, it must be remembered, there were many who denied the possibility that wholly random variations could furnish an adequate basis for evolution through natural selection.

In recent years, this difficulty has been magnified many fold. A large part of the variability of organisms, including many differences of survival value in the struggle for existence, are believed to be "somatic" or "phenotypic"—that is to say, non-hereditary. In respect to any given character, so much of the variability as is found to be inheritable is attributed to the action of relatively small numbers of unit-factors, which can be readily, and rather speedily, segregated in particular descent lines, if the degree of selection is rigid enough. Thus a very limited amount of permanent modification may be brought about fairly promptly. After that, we are forced to wait for the decidedly capricious process of mutation to help us further along the road.

One having a limited acquaintance with the discoveries of Morgan and his co-workers might be disposed to exclaim at this point: That is easy! New mutations are coming to light every day in the case of *Drosophila*. Would not this prove to be true with every race of organisms, if studied intensively?

I fear that such persons are leaning on a very frail reed. When we examine into the nature of these mutations of the fruit-fly, we find very little promising material for a theory of progressive evolution. Many of them are obvious deformities and abnormalities, not only in the sense of being departures from the typical condition, but in the sense of rendering the insects unfitted for life in nature. The body may be warped, the wings so abbreviated as to be useless, the legs duplicated or greatly shortened, the eyes reduced in size or suppressed altogether. Many of the mutant factors described by these authors belong to the class known as "lethals." That is to say, their presence in a homozygous condition results in the death—or failure to appear—of all the organisms so affected. Indeed, most of the mutant strains are distinctly less hardy, or more difficult to raise, than are flies of the wild type. The best that can be said for any of the modifications thus far appearing is that they are harmless to the organism. Those which are not positively deleterious consist in changes in the color of the body or eyes, in the number or form of bristles on the thorax, and other trivial departures from the normal condition. So far as I know, not a single one of these mutations—and there are some two hundred of them described—can be said to represent a better adapted type of organism. With a very few exceptions, they consist in obvious losses of structures or materials previously present.

We are not, of course, warranted in concluding from this that mutations of evolutionary value never occur. It is quite possible that they do. But what we actually know at present re-

garding such mutations as occur in our breeding cultures affords no safe ground for the belief that evolution has come about through the accumulation of these by natural selection.[2] This belief seems particularly difficult in the case of very slow breeding animals, such as the elephant, which have none the less undergone enormous structural modifications during relatively brief periods in the earth's history.

Here then is one difficult situation in which we find ourselves, if we follow the lead of the majority group of biologists in questioning the positive effectiveness of the environment as an agency in evolution. Are we not brought back to a viewpoint similar to that of Naegeli, who held "that animals and plants would have developed about as they have even had no struggle for existence taken place, and the climate and geologic conditions . . . . . been quite different from what they actually have been?"[3] According to Naegeli, the environment has had merely a pruning effect upon the tree of life, eliminating certain branches and permitting certain other others to grow. If this be the truth, we must, of course, accept it. But we should accept it on evidence, and not on authority.

That the environment may have had a far more positive influence upon evolution than is admitted by the Mendelian-Mutationist school of biology is further rendered probable by certain recent experiments. I refer particularly to the remarkable work of Guyer and Smith upon the inheritance of artificially induced eye defects in rabbits. The studies of these authors seem to prove conclusively that one particular class, at least, of "acquired characters" may be transmitted indefinitely from one generation to the next. And the mechanism by which these acquired characters seem to have been registered in the germ-cells is of a type which is conceivably operative on a large scale throughout the living world. I am waiting with interest to see whether the results of these remarkable experiments are to be explained away or robbed of their significance for biological theory.[4]

Another field in which this depreciative attitude toward the power of environment is at present conspicuous is that of eugenics and the study of character formation in man. Since I have recently

[2] Professor Bateson, who is usually regarded as a pioneer "mutationist," has recently declared (SCIENCE, January 20, 1922) that "we have no reason to suppose that any accumulations of characters of the same order" [*i. e.*, "transferable" or segregating ones] "would culminate in the production of distinct species."

[3] Kellogg (Darwinism Today, p. 278).

[4] For present purposes it is immaterial whether these phenomena be attributed to "parallel induction" or to "somatic induction."

published a special article on this subject,[5] I shall take the liberty of quoting rather extensively from this. My first object in the article referred to was to point out the very general confusion which exists regarding the relations between heredity and environment in human development.

"Every 'character' (whether we mean by this word a bodily part or organ, or a trait or mental disposition) has a hereditary basis. Likewise, every character is due, in its final state, to the interaction of this hereditary basis with other parts of the developing body, and with the sum-total of external conditions, physical and biological, which we call the 'environment' of the organism.

"However, it seems quite proper to speak of *differences* between two organisms as due solely to heredity or solely to environment. Thus plants of different stock, reared under identical environments, might differ greatly in size or in other respects. These differences would be of purely germinal origin. On the other hand, two plants of identical heredity might be reared in different soils and come to differ widely in size or otherwise. Such differences would be purely environmental.

" . . . . The familiar question, Which is the more important, heredity or environment? is not capable of answer when stated in that form. One might as well ask, Which are the more important in the construction of a house, the building materials or the carpenters? We may, however, as just indicated, frame the question in another way: Are the *differences* which we observe among our fellow men due chiefly to *differences* of heredity or to *differences* of environment, using the last term in its broadest sense?[6] Even here, we must be more explicit. Do we refer to the differences between the white man, the Chinaman, and the negro, or do we refer to the differences which we observe among individuals of the same race? The differences between the various races would be granted by most persons to be hereditary. But the differences within a given race are regarded by many as being due, in large degree, to the circumstances of life—to feeding, home surroundings and 'bringing up.' This is claimed particularly for the mental and moral characteristics."

"Francis Galton, after reviewing the evidence derived from the study of identical twins, thus expresses his belief regarding the relative potency of heredity and environment in determining human differences: 'There is no escape from the conclusion that nature prevails enormously over nurture, when the differences of nurture do not exceed what is commonly to be found among persons of the same rank in society and in the same country.'

"And truly, I do not see how we can escape this conclusion, if we bear in mind Galton's reservation. . . . .

"I think it likely, however, that many recent geneticists, especially some of those who are active in the eugenics movement, would throw out Galton's reservation and insist that 'nature prevails enormously over nurture' in determining the mental and moral differences among an entire population, regardless of its social strata.

"The opposite, or 'environmentalist' philosophy, in its extreme form,

[5] Heredity, environment and responsibility. Bulletin of the Scripps Institution, No. 10, July 2, 1921.

[6] See Popenoe and Johnson, "Applied Eugenics," p. 3.

would assert that almost any individual may be given almost any type of physique, intellect, or moral character, if taken sufficiently early and subjected to a proper regimen during the period of growth and character formation. . . . .

"It is my own belief that the scientific geneticists and eugenicists are much nearer the truth than the mere undisciplined lovers of mankind, but that they have been led into a somewhat extreme position by their efforts to square the facts of life with certain biological theories. Now there are various considerations of a strictly scientific nature which would seem to establish the presumption that non-inherited factors in the formation of human character should be given more weight than is frequently accorded them by biologists."

The time at my disposal does not permit of an adequate discussion of these considerations. I shall restrict myself to a brief mention of one of them. This is the probability, admitted by most biologists, that civilized man has undergone little if any improvement in his inherent mental make-up since the dawn of history.

While it is not necessary to admit such extreme claims as have been made by some biologists, I think there is no escape from the conclusion that mankind, or the civilized part of it, has made *little* advance in potential brain power during the entire period of history—little in comparison with his racial achievements in science, philosophy, art, invention, morals, etc. In other words, human progress has been extrinsic rather than intrinsic. We have built up an enormously complex world of racial acquirements, consisting of customs, laws, and knowledge, as well as all the physical paraphernalia of civilization.

Thus, if it is really true that the innate brain power of mankind has undergone little or no increase since paleolithic times, the higher mental status of the modern man is due almost wholly to a fuller development in each of our lives of potentialities which were present in the man of the Old Stone Age. This, of course, is but another way of saying that even such enormous differences as distinguish a Cro-Magnon cave-dweller from a modern European are chiefly, if not wholly, environmental.

It may be worth while, in the interests of clear thinking, to undertake an analysis of this distinction which we are so prone to draw between organism and environment. How far is this antithesis a real one, and how far is it a mere matter of convenience? Let us consider this question, first of all, in its bearing upon the science of genetics.

The sum-total of causal agencies which result in the production of a complete organism from a fertilized ovum are commonly grouped under two heads: (a) the material constitution of the fertilized ovum itself, particularly of its chromosomes; and (b) external influences which act upon the developing organism, from

the moment of fertilization to the close of the life cycle. This classification corresponds in the main to the familiar antithesis between heredity and environment, nature and nurture. As a matter of fact, the distinction thus drawn is largely a chronological one, the influences acting before fertilization being lumped together along with "nature," those acting after that event being assigned to "nurture." If we insist that heredity relates only to the "intrinsic" factors in the situation—to the material constitution of the "germ-plasm" independent of environmental influence at *any* period—it seems to me that we are dealing with something purely imaginary. There never is a period in the history of the germ-cells or their forerunners when they are not vitally dependent upon their living environment. Every step in their history involves an interaction between certain factors which may be called "intrinsic" and other factors which are external to these. What is "intrinsic" at one moment may have been "extrinsic" the moment before. Whether this relation is of a type which makes possible the form of inheritance assumed by Lamarck is a question which we need not consider here. I merely wish to point out that no hard and fast distinction can be drawn between heredity and environment as conditioning the life of an organism. The distinction is largely one of chronology, and the moment of demarcation between the two must be chosen rather arbitrarily. In practice, to be sure, the distinction implied by these words is in the highest degree useful. But we should not imagine that it is an absolute one.

It may be of interest to carry this analysis a step further. I am prepared to defend the somewhat paradoxical thesis that the organism and its environment constitute an inseparable whole; that if we could detach all environmental elements from this complex there would be no organism left. Nor do I intend this as a mere bit of Hegelian dialectic. A moment's reflection serves to show that we can draw no sharp line of division, not even a theoretical one, between the two.

If I should ask you whether the nest of a bird constituted a part of the organism or a part of its environment, I presume that every one present would resent the question as an insult to his intelligence. Nor would there probably be any hesitation if the question related to the patch-work dwelling of a caddis-worm, even though this dwelling is carried around by the larval insect, as if it were an integral part of its body.

The situation becomes somewhat less clear, perhaps, when we consider the calcareous tube of a marine annelid. Here is something which is definitely secreted by the epidermal cells of the organism,

and which forms a sort of permanent integument. It does not, however, in this case, retain any organic connection with the body of the worm. But when we pass to the shell of a mollusk we find that there is such an organic connection with the body, so that the animal cannot be dislodged without extensive injury to its living tissues. Moreover, the purely mineral ingredients of the shell are sandwiched in between layers of a substance which we commonly speak of as "organic," though not in this case as living. Does such a shell belong to the organism or to its environment?

If there be any doubt in the case of the mollusk, let us consider the bony carapace of the tortoise. This, likewise, is composed in part of mineral salts, in part of equally lifeless "organic" materials, produced through the metabolism of living matter. But in addition to these lifeless elements, we here encounter a multitude of living cells contained in minute spaces scattered throughout the bony substance; and even blood-vessels and nerves, which provide for the nutrition and growth of these cells. All persons would probably agree that such an exoskeleton belongs to the creature's body.

Let us pass next to a consideration of the internal fluids which are concerned with distributing food and oxygen to the living tissues and with carrying away their waste products. Perhaps a reversal of the order previously followed would here be instructive. In the case of vertebrates, the blood is itself commonly classed among the tissues of the body. Cells of several kinds are present, along with a fluid, intercellular matrix consisting, in large part, of proteid substances, approaching in complexity those which compose the "protoplasm" of the living cells.

Among the mammals, the blood maintains a high degree of constancy in its composition, regardless of changes in the external medium. A seal or a porpoise may pass from fresh to salt water, or vice-versa, without undergoing any change in the concentration of the blood. This is not true, however, of the fishes. Those which are capable of living equally well in fresh and salt water show a higher salt content in the latter than in the former.

Now among fishes—or at least the bony fishes—this concentration of salts in the blood is not proportional to that of the water in which they happen to be. But the case is quite different with many marine invertebrates. As a result of osmosis and diffusion both the concentration and composition of the salts in the body fluids of such animals is rapidly brought into conformity with that of the water in which they are placed.

In the coelenterates, it is well known that the gastrovascular cavities and their contained fluids are in direct connection with the

surrounding ocean, while in the sponges the only circulating medium is the sea-water itself, which is propelled through multitudinous canals by the motion of the flagella. Once more, is it not obvious that the distinction between organism and environment is a conventional and arbitrary one?

This line of argument would be quite incomplete without reference to the transformations which constitute that most characteristic process of living matter, metabolism. Unfortunately, my limited knowledge of biochemistry would not make it possible for me to discuss the subject adequately even if my allotment of time permitted. But even such slight knowledge as I do possess enables me to assert with confidence that there is no definite point in the process at which we can say for the first time: This is no longer food; it has become living matter. Nor, on the descending phase of the metabolic cycle, is it possible to distinguish the moment at which the living passes over into the non-living. But food and waste matters belong to environment. They can hardly be regarded as parts of the organism.

In short, the organism and the environment interpenetrate one another through and through. The distinction between them—let me repeat—is only a matter of practical convenience. Should not such considerations affect our attitude toward the propriety of neglecting the environment as an object of biological research? I make no pretense, of course, that such neglect is universal. An active and important group of present-day biologists is giving its chief attention to the organism-environment complex. My criticisms—so far as I have made any—relate to general tendencies and average conditions, and these have not, I believe, been unfairly portrayed.

CONTROL OF PROPAGANDA AS A PSYCHOLOGICAL PROBLEM[1]

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AN interesting phenomenon of the last few years has been the unanimity with which millions of men and women have conformed in their thinking and in their actions to what certain leaders wanted. Vast sums of money have been raised for liberty and victory loans, for the Red Cross and for many other agencies. Citizens of the United States consented to universal conscription, cut down their daily use of sugar, closed down their factories on certain days, and went without gasoline for their autos voluntarily and enthusiastically. To an extraordinary degree men and women in nearly all the countries of the world have cooperated in carrying out programs necessitating radical changes in their every-day life; and they have done so not because they were ordered to do so, and so were forced to it, but because they freely responded to suggestions presented in skillfully conducted propaganda.

Because of the surprising success of all this propaganda, the innumerable times it has been employed and the ease with which it has been carried out, people generally have become conscious of propaganda as a great tool or method for influencing others. Propaganda has, of course, existed for ages. But it has not been comprehended so clearly by the mass of people as it is to-day. And certainly it has never before been employed on such great numbers of men and women. To-day it is a clearly recognized method of social control.

If propaganda were a means of influencing others along lines only of benefit to society, it could be hailed with great acclaim. But unfortunately it can also be employed for dishonest and socially vicious programs, just as well as for honest and worthwhile movements. At the present time the advertising of patent medicines that can not possibly cure, and of stock in companies formed for no other purpose than to defraud the public, appears

[1] Retiring vice-presidential address before Section I, Psychology, American Association for the Advancement of Science, at Toronto, December 30, 1921.

in altogether too many of our publications. Federal authorities estimated that in five years, 1910-15, the 2,861 swindlers that were arrested had defrauded the public of $351,000,000, averaging a dishonest gain of $123,000. All authorities are agreed that such swindling increased very greatly during the war, and possibly reached its climax some time after the armistice. If so, it is now on the decline. Let us hope so!

The drive, a new form of propaganda, has now become a regular business. According to James H. Collins, somewhere between a billion and a billion-and-a-half dollars have been raised in one year for various causes other than governmental. Many of these have been worthwhile, but unfortunately many have been the reverse. A bureau that makes a business of investigating national and interstate money-raising activities, reported that by April, 1920, the number of drives had risen to 1,021, of which the bureau approved only 124. The district attorney of New York County investigated 534 money-raising activities in 1918 and put 384 of them out of business. One gang of ex-convicts had obtained $500,000 in eight months.

But we are less concerned here with swindling propaganda than with those forms not so palpably dishonest. It is important that our citizens be protected from pecuniary loss, but it is far more important that the United States, for example, deals with Russia, Mexico and the Irish question in the right way. And it is just such problems that furnish us with propaganda very difficult to handle.

As a case in point, consider the Russian situation. Those opposed to the Bolsheviki have attempted to destroy the movement by linking it up in our minds with the fact that the Bolsheviki were under German influence, that they were anarchists, that they were guilty of murder and atrocities, that they persecuted the Church, that they had nationalized women and were deliberately corrupting the morals of children, and now, recently, that their government is so unstable that we can not do business with them. The friends of this political and social revolution have told us entirely different stories. And so-called unbiased persons have often made statements which do not agree with what any one else has set forth.

Consequently to-day the average citizen confesses he really does not know what the facts are in this and many other important issues. He has been deluged with facts, near-facts and falsifications put forth by interested parties, so that he has a mass of undigested and conflicting ideas on these subjects, or else has become frankly partisan to one view.

President Butler, of Columbia University, recently called attention to the dangers to society of this sort of thing. "Liberty," he said, "which once was endangered by monarchs and by ruling classes, has long since ceased to fear either of these; it is now chiefly endangered by tyrannous and fanatical minorities which seize control for a longer or shorter time of the agencies and instruments of government through ability and skill in playing upon the fears, the credulity and the selfishness of men."

The question naturally arises, is there no way of controlling propaganda? Certainly there are ways and they are enforced more or less in the case of certain types of propaganda. But there are other types which are not so easily evaluated and consequently not so easily handled.

A perusal of literature on this subject gives one the impression that very few to-day are sincerely interested in the matter, except those apparently who desire to control or eliminate propaganda directed at their own. It is still viewed as highly ethical for us to sort and reject and trim in the name of our own view of truth, justice, democracy and loyalty to our group. But it is anti-social for the other fellow to do so. If we are Republicans we want the editor of our newspaper to give us good Republican views and to damn the Democrats. If we are Democrats, we want the reverse. We really want "facts" that support our views. It is too uncomfortable to be confronted with many counter "facts."

Naturally as a psychologist, I view this matter as an interesting psychological problem. It is my purpose in this place to discuss certain psychological aspects of the subject and to point out some of the ways in which propaganda may be controlled. It is also my purpose to call attention to certain types of propaganda which at present I see no way of controlling, in the hope that others may become interested in the subject and labor to work out some adequate methods.

First of all let us clarify the use of certain terms which are employed in discussing the subject and at the same time come to an understanding of the psychological elements which are involved.

The word "propaganda" means essentially the spread of a particular doctrine or a system of principles, especially when there is an organization or general plan back of the movement. Propaganda differs from "education" with which it is purposely confused, in that in the case of the former the aim is to spread one doctrine, whereas in the case of the latter the aim is to extend a knowledge of the facts as far as known. Advertising men have never been able to agree on a definition of "advertising" and I should not want to attempt here what they have failed to do. But

I think we can distinguish between advertising and propaganda by saying that advertising is usually concerned with making known and desirable a definite commodity or service with the definite aim of leading many individuals, as such, to acquire the commodity or service. Propaganda includes many types of advertising, but it is mainly concerned with the subtle presentation to the public of information so chosen and so focussed that among many individuals there develops a general "point of view" which is favorable to the aim of the propagandist and leads to action in that general direction. A further distinction between these two methods of influencing people pertains to the *methods* employed rather than the *object*. The advertiser buys space upon which appears his message, and the reader knows it a paid advertisement. The propagandist may advertise, but he especially aims to employ space he did not buy, at least directly, and not to permit the reader to know that the material is propaganda. He believes his material will have greater effect when its source is unknown.

It is clear that both advertising and propaganda make use of argument and suggestion. And much has been written and said as to these two methods of influencing others. We have no quarrel in this paper with argumentative or "reason-why" appeals to the public. But we are very much concerned with appeals involving suggestion.

The term "suggestion" has been employed in a great variety of ways, sometimes in a narrow sense, but usually in a rather broad and indefinite way. Frequently it is used to cover all the means of imparting information and exerting influence other than through reasoning. Without going into the subject here, let us recognize three phases of non-rational influencing of others. In the simplest form one or more ideas are presented which are known to be associated in the minds of the audience with another idea not mentioned. The audience thinks the non-mentioned idea because of their established habits of thought. In this way a speaker may denounce most viciously and unfairly a prominent man without giving his name, by skillfully referring to one or more of his known characteristics. The desired effect is accomplished and without making it possible for the prominent man to reply. Then there is the more complicated phase of suggestion where an *action* is brought into the mind of the audience—the action being a familiar one and also one that will be desired as soon as mentioned. Thus a school boy at recess says, "Let's get a drink." The other boys might not have gotten a drink if they had not been reminded of the action. But as soon as it is called to mind, they feel the desire and so go. So also a nation like Ger-

many, all primed for war, as in 1914—I don't refer here to her military preparations, but to the state of mind of her citizens—was ready to act immediately when her leaders said "Let's fight." It was the absence of just such a mental state in the United States that kept us out of war. Later on the attitude was developed—almost over-developed before it had a chance to function—and we were eager to act when the word was given.

In both these phases of suggestion the effect is produced because there exists within the mind of the person being influenced certain habits of thinking and action and when the proper stimulus or cue is given the associated thinking and acting immediately follow. There is still a third phase of suggestion, which I prefer to call motivation, in which a person is led to do something which is unfamiliar or which he would not do if it were merely mentioned. It is because of this third method of influencing others that the control of propaganda is so difficult. Let us see what this process of motivation is.

Consider an example: An electric light and power company launched a newspaper campaign some time ago in order to sell vacuum cleaners. The appeals were made to women to buy the cleaners in order to save labor and to make their homes cleaner and healthier. Many cleaners were sold. But the stock on hand was far from exhausted. Some time later the company launched another campaign, in which they directed their appeals to husbands, not wives. In these advertisements they depicted, for example, a successful business man in his office surrounded with filing cases, typewriters, dictaphones, and the like, and in another cut, showed the wife at home with a dust-cap on her head, sweeping the dining room, with the dust flying all about. The caption underneath read something like this: "Why not equip your wife's office like your own?" This second campaign sold more vacuum cleaners than the first one. Why? Because the man's love for his wife was aroused and this strong force was coupled to the idea of vacuum cleaners. Buying a vacuum cleaner then became a most satisfactory manner of expressing love. In advertising to the wives, on the other hand, no such fundamental motive was aroused. The vacuum cleaner would save labor, it is true, but it would not give to the wife as much satisfaction for the money as a new rug to be seen by every one coming into the home, or as new clothes for the children.

In this case we have men led into doing something they had no intention of doing, of buying something that little concerned them, and that they probably knew very little about. They were so led because love for their wives was aroused and they were

shown how this love could be very adequately expressed. With minor changes, the advertisement could have sold them an electric washing machine, or any useful household device. They were not sold, then vacuum cleaners so much as they were the satisfaction of pleasing their wives.

Motivation involves two elements—first, the arousal of a strong desire, and, second, the presentation of a certain action which appears to be a satisfactory way of expressing the aroused desire. Moreover the action in such cases is not one that the individual would perform if it were merely suggested.

The question has often been discussed: Could the United States have declared war in 1914? I think there is no doubt that there was insufficient war sentiment at that time to have permitted mere suggestions from the President to be effective. But I think there is also equally no doubt that proper propaganda would have motivated the country into war. The years 1914 to 1917 may be looked upon as a period in which such sentiment developed and was finally put into action in a calmer and far less emotional manner than usually prevails at such a time.

Recent work in psychology has emphasized the distinction between an "idea" and a "sentiment." The sentiment, according to Rivers, is an idea emotionally toned. "House" is thus an idea, whereas "home" is a sentiment, for home always includes an emotional consciousness of mother and father, brothers and sisters, old familiar associations and the like. When the sentiment becomes suppressed and lost to consciousness it is called a "complex." Sentiments and complexes, we are coming to see more and more are extremely important in explaining behavior; much of abnormal conduct being traceable to the existence of complexes.

Motivation is thus the process of deliberately developing a sentiment, of deliberately associating an idea with an emotion, of tying together in the mind of another the love for wife and the idea of buying a vacuum cleaner, or of sympathy for the Belgians and hatred of the Germans, and the idea of war.

The aim of propaganda is to develop sentiment and then precipitate action through mere suggestion. Let us consider some implications which are involved in all this.

First of all let us note that theoretically any emotional element can be associated with any specific line of action. Practically, certain combinations are difficult to accomplish, but theoretically they are possible. Thus, the correspondence school arouses the boy's love for his mother and challenges him to make her proud of him and "funnels" the aroused emotional desire into taking a correspondence course. The same appeal could be utilized to get

young men to go to church, to quit gambling, to work harder for their employer, to enlist when war is declared, to do anything the boy could be made to believe his mother would approve of.

In the last political campaign for President of the United States, the maternal instinct was appealed to by both sides. A Democratic editorial appealed as follows:

"Mother of America! Mother of Pennsylvania! Mother of Pittsburgh! Do you want your boy to go to war? Is the roll of battle drums sweeter in your ears than the song of his voice in the home? Would you rather have his hands in fierce grip on gun in battle's rack than have his arms in love about your neck? That is the question you must answer to your God and your fellow-man when you go into the voting booth on November 2. Do not let demagogs confuse you. The issue is plain: A vote for the league is a vote for peace; a vote against the league is a vote for war. . . . Mother of an American boy! The munition makers of the world are arrayed against American participation in the League of Nations. They are snatching at your vote, because with it they may claim the body of your first-born. Mother of a Pittsburgh boy! The question comes home to you! Your boy was not born to be food for guns."

A Republican advertisement stated in part:

"Women! For your own good vote the Republican ticket. . . . The American woman asks of her country: That it be a secure place for her home and for her children and that it be security with honor. That it give her children opportunity to lead their lives even better than she and her husband led theirs. That it be just in its relations with other nations, and merit the pride which the best of its citizens have in it, in its history and its ideals. A policy which has these purposes will have the support of American womanhood and American motherhood. That is the Republican policy and has been Republican policy from the days of Abraham Lincoln. The Republican policy is to protect the security of the United States by preserving its right to make decisions regarding its actions in the future as events in the future demand. The Republican party is unwilling to pledge now that it will protect European boundary lines and to deprive Congress of the power to say in each case what the action of the United States will be. . . ."

Here we have the same instinctive emotional element aroused and then associated with two diametrically opposite lines of action. Both of these articles are intended to arouse a mother's love for her boy and consequent horror of war, and then show that her desire could be best obtained by voting the Democratic ticket in one case and the Republican ticket in the other.

A second fact can be considered regarding motivation. It is that no logical connection needs to exist between the emotion which is aroused and the program which is outlined. And further still, there need be no logical establishment of the fact that the program is really the best one to be pursued or even that it is honestly conceived.

Consider the propaganda for the Red Cross, an organization for which we are all enthusiastic. The Red Cross has rendered inestimable service. And because its work has touched our hearts a real sentiment has been built up about its name. So strong is this sentiment that one now finds himself unable to resist the request for annual dues. But my friends—I have asked several—and I do not know whether all the money that is now raised is really needed, nor how it is spent, nor whether the organization is efficiently administered or not. I am not saying this in the way of criticism: I am only pointing out that when one's emotions have been properly aroused one acts as directed and without intellectually considering the matter.

Take the recent "Clean-up and paint-up" campaign as another illustration of what most would call a worthy propaganda. A trade journal, The American Paint and Oil Dealer, started it off with an editorial in May, 1912, in which it was pointed out that for many years there had been special campaigns inciting people to clean-up their towns and their neighborhoods for some specific gala occasion. It was now time "to back the idea that you clean up and paint up and keep cleaned and painted up, not just once a year, but the whole year through." "The idea was to inculcate into the minds of people pride in home and city, and in thrift and cleanliness, and to appeal to that pride to the end that it might be organized and wisely directed for the benefit not only of the paint industry, but of the whole United States of America. Enlisted in this campaign were various types of people. Material was prepared that appealed to every one of these types in a most specific manner."

R. F. Soule writing in Associated Advertising tells us how Chambers of Commerce were the principal bodies that helped put the campaign over. He describes how fire departments were aroused to the need to prevent fires as well as to put them out; how police departments became much more interested in enforcing sanitary ordinances along with the street-cleaning departments; how women's clubs helped the good work along; etc. In 1920 there were 7,000 towns and cities engaged in this campaign. And illustrative of the work accomplished it is reported that in Cincinnati 384 buildings were torn down that were a fire menace and

the city so cleaned up as to lessen the annual premiums for fire protection by $850,000.

According to Soule not over $25,000 was spent in any one year by the organization back of this campaign, although a great deal of publicity was given in newspaper editorials and in the advertising of many companies in connection with their own products.

Now note: This campaign is characterized as having been unselfish. The big idea was not to sell merchandise, it is claimed, but "to sell the people of this country citizenship, pride of home and ownership, and a desire to be of greater service to the community of which they were a part."

These were the motives, desires or wants that were aroused and then hundreds of business men saw to it that they were expressed by way of buying their goods, whether it was paint, oil, lawn mowers, flower seeds, or even safety razors. Clearly any emotional desire can be coupled up with any line of action and there needs to be no real logical connection between them.

Propaganda depends upon this psychological process of motivation for its success. And motivation, as we have seen, is the deliberate process of arousing one's emotions and desires and then suggesting a line of action by which these desires may be expressed. And we have seen further that any emotional element can be associated with any specific action; and that when one is well motivated he ignores intellectual considerations touching upon the honesty of the statements or the efficacy of the program.

So much for our analysis of motivation—the principal psychological process in propaganda. Now let us consider how propaganda may be controlled by society so that dishonest and pernicious campaigns may be prevented without interference to worth while propaganda.

The most convenient method of considering the many angles of the subject will be through discussing propaganda in terms of the following three aspects: First, propaganda considered with regard to the truth or falsity of the statements in which it is presented; second, with regard to the action suggested as the means of satisfying the aroused desire; and third, with regard to the emotional element, the desire that is aroused. The matter of control can accordingly be discussed in terms of these three question: First, how far can propaganda be controlled in terms of the validity of the statements which are made? Second, to what extent can propaganda be controlled in terms of the action which is proposed? And third, to what extent can propaganda be controlled in terms of the emotional elements that are involved?

First of all, then, how far can propaganda be controlled in terms of the validity of the statements which are made?

Society has long dealt with false statements and already has postal regulations, laws against slander, libel and the like. To protect politicians the English law provides a fine not to exceed £100 if the name and address of the printer and publisher is omitted from a poster relating to the candidature of any person for Parliament and other offices. The Association of Advertising Clubs of the World carries on a steady campaign against dishonest advertising and has accomplished a great deal of good against this type of propaganda. At this time, thirty-six states have passed the Printers' Ink Statute or a modification of it, thereby facilitating convictions in such cases. And the Association of Advertising Clubs of the World is spending money and effort in enforcing it. Control of propaganda publicly making dishonest statements can clearly be taken care of.

But unfortunately many undesirable propaganda will not fall under the class of propaganda publicly making dishonest statements. One very undesirable sort is spread by word of mouth. No one knows from whence it comes, and exactly what is back of it. We had many stories thus circulated against the Germans during the war, and we have the same sort of thing carried on against prominent men almost all the time. Stories of Roosevelt's excessive drinking were thus circulated. And it was not until they were publicly expressed that he had an opportunity of disposing of them through law suit. Such word of mouth propaganda is fostered in times of emotional stress and particularly wherever people believe they are not being told all the facts. The best possible cure for it is publicity of the sort that makes people *believe* they are getting all sides to the question.

But in addition to this sneaking underhand propaganda there are all sorts of campaigns which are very undesirable, but which adhere technically to the truth. They cannot accordingly be prosecuted for dishonesty. Some of them, however, give false impressions just the same. This is so because the human brain does not necessarily think in a logical manner. For example, the statement, "No watchman here between 6 P. M. and 6 A. M." means just that and no more, but actually the effect is as though the statement had gone on to say that a watchman was on duty in the day time. For a distributor of a food product to advertise that his goods contain no arsenic is to give the impression that the goods of at least one of his competitors do contain that poison. And the lurid page description of two successful gushers between which the advertising company's property is located gives the impression one is surely buying stock in a gusher-to-be, even though the company's property may be several miles from either of the described oil wells.

Then there are other kinds of propaganda which deal with this subject in such a general way that no one can challenge their statement. One of the packing companies ran an advertisement some time ago which came no nearer to stating facts than this: "Possibly, we are partially to blame for the lack of understanding which exists in regard to our business. In the past, knowing that attacks upon us have been based on tissues of half-truths, adroitly handled inuendo and misinformation, we may have forgotten that the public were not in full possession of the facts." The statement is a very clever one, undermining criticism without giving a single fact in reply except the company's own belief that all attacks have been based on half-truths.

To require that propaganda contain truths and not falsehoods is a desirable regulation, but it will not stop undesirable campaigns.

Let us consider second to what extent propaganda can be controlled in terms of the action which is proposed.

If the proposed action is that of buying, it is not difficult to evaluate the propaganda, or advertising as it would usually be in this case, upon the grounds that the individual did or did not get value received. But if the proposed action is that of giving money for some cause or charity, justification upon such grounds is far more difficult. If a woman, very fond of cats, wants to endow a hospital for them, run by thoroughly incompetent people whom she likes, isn't that sufficient to justify her action and the propaganda, as far as she is concerned? It is hard to attack such action in terms of the rights of individuals, but it is being more and more attacked upon the grounds of social welfare. Business men through their Chambers of Commerce in sheer defense are increasingly investigating such propositions and in many places list the charities that they will countenance. Out of the war has come the Community Chest movement whereby all social agencies in a district make up their budgets in advance and after they have been gone over by both disinterested and interested parties, a single united effort is made to raise the total amount in one campaign for the year. Such plans help the worthy cause and interfere with the unworthy one. But they do not eliminate the unworthy campaigns.

The establishment of bureaus, whose business it is to investigate all organizations asking for funds—organizations like the National Information Bureau—renders it easier to determine whether any organization is desirable or not. Can society go farther here? Can society not only positively help the worthy cause, but put the unworthy, inefficient or unnecessarily duplicating agency out of

business? There is no question but that many individuals are being fooled every year and much money squandered through such non-worthwhile causes. But at the same time, we must remember that most new uplift movements have encountered great opposition at the start, and to increase this opposition still more through the establishment of legal regulations may do society in the long run more harm than good.

In addition to campaigns to sell a commodity or service or to obtain gifts, there are other campaigns devoted to accomplishing specific actions of a sort much more difficult to estimate fairly. Political campaigns aim to secure votes for certain men; propaganda appears from time to time to influence citizens to vote for or against certain measures; propaganda appeared in many forms a short time ago, appealing to citizens of the United States to intervene in Mexico; lobbies are familiar accompaniments to our legislatures, each one aiming to accomplish a specific program; unions appeal to public opinion to aid them in winning a strike and companies appeal to the same public to help them prevent or break the strike, etc. We are so accustomed to our political machinery that we do not often stop and ask ourselves whether it is geared up so as to serve society in the best way. Only when some enthusiastic social uplifter boasts that she and four others alone put a measure through a state legislature by the use of skillful lobbying, or a secretary of a business man's organization calmly announces months in advance that Congress will do away with a bureau because his organization is demanding such action, and his prophecy comes true, does one wonder whether some sort of control of propaganda would not be worthwhile even here. And one waxes quite indignant, as did a former Secretary of War, when he comes to realize that much of the propaganda for bringing back the bodies of our dead soldiers was instigated by the journal of the undertakers and casket makers.

To control such propaganda we must have facts and we must have a body to review the facts. This we do not have in many cases. A political campaign on a clean-cut issue is supposed to be a trial as to the merits of the two sides before all the citizens who through their votes decide the issue. This is the theory of democracy. It works pretty well in many cases, surprisingly well in some. But in most campaigns the issue is not clean-cut and in nearly all campaigns the political strategist endeavors to confuse the issue, so that many a time a citizen votes against what he really wants. And then there are many measures coming up in our fearfully complex life of to-day upon which the average man is not at all competent to pass judgment. Except in a few instances, so-

ciety has not yet organized itself so as properly to handle such matters. In the case of struggles between capital and labor, we are steadily advancing toward the insistence upon both sides that they shall present the facts as they see them and also toward the establishment of tribunals which shall weigh all the facts and decide the issue. The impartial chairmanship program maintained by the clothing industry in Chicago and other cities has worked very satisfactorily and seems to be the ideal machinery for controlling propaganda in that field. Its greatest merit lies, it seems to me, in the fact that complaints are studied and evaluated very shortly after they arise, thus eliminating the getting under headway of extensive propaganda with all the arousal of emotions that propaganda assures.

But there are many issues to-day, strongly supported by a minority, regarding which it is difficult to obtain facts. And as long as one side is insistent and the other side largely indifferent, society cannot expect that the minority will present facts regarding their claims. For it is not facts that will sell the program, but emotion and the emotion which is aroused needs not be logically connected with the issue. So a few harrowing tales of deserted mothers and their poverty stricken children bring us a mother's pension program because a few people believe this is the best solution. Possibly it is. I am not here arguing the case. But how much real thinking has entered into the matter by disinterested parties before a legislature has voted!

We have briefly considered the possibilities of controlling propaganda in terms of the action which is proposed—when the action is that of buying, giving money, or gaining support for *definite* political or other issues. But there is an entirely different type of response which some propaganda aims to accomplish. It is that where no definite act is suggested, at least directly, but where public opinion is to be changed. Pro-German propaganda before and during the war, or pro-Irish propaganda to-day, or the New Era Movement of the Presbyterian Church, or the International Typographical Union advertising in the newspapers do not aim at getting any one to do a specific act. What is aimed at is the development of a broad sentiment with the perfectly clear understanding that when this sentiment is established the individual will do something to forward the cause. To evaluate the propaganda in such cases, the entire program must be considered. And as individual members of a big movement emphasize different aspects it is very difficult to determine just what the movement stands for. For example, legal action was instigated some time ago against a union because in its constitution, if I remember correct-

ly, it stood for a soviet type of government. But no progress could be made because no specific action had been taken by the union, openly against the laws of the United States. Now possibly the constitution as far as this point was concerned was and had always been a dead letter. But possibly the point was the very heart and center of the union's life. Still, how can its propaganda be limited until it has resulted in definite action? But if it cannot be controlled until anti-legal action commences, then there can be no control of such situations until most of the harm (or good) has been accomplished. For if the propaganda has accomplished the establishment of a certain sentiment without interference and then specific action has been suddenly advocated, no legal machinery in existence can stop the action. The existence of a sentiment in Great Britain, that treaties to which they were a party must be observed, was one of the factors that forced that nation into war with Germany when the latter violated the neutrality of Belgium. As Sir Edward Gray said, "My God, what else could we do!"

There is another very vexatious phase of this point. When a sentiment has been established the individual may do almost anything which he feels will advance the cause in which he is interested. Can a propagandist be held responsible for the actions of his followers because he stirred them up originally. A newspaper publisher's propaganda against McKinley may have caused that president's assassination, as some have felt. But is the publisher responsible for an act he did not specifically advocate, even though, for the sake of argument here let us say, he did stir the assassin emotionally and against the President? The newspapers report the non-cooperation propaganda of Mahatma Gandhi of India and how this leader is fasting one day a week in protest against the rioting which his followers are indulging in. To maintain that the publicist is responsible for what his followers do seems very unfair: to hold that he is entirely unaccountable opens the way for most subtle and dangerous attacks on society.

This leads us squarely up to the issue: shall propaganda be evaluated only on the basis of the actions that result or on the basis of the motives back of the propaganda?

Our law basically concerns itself with man's behavior and takes little account of motives. But a distinction is made between wilful murder and unintentional manslaughter. And a man can be convicted of murder if a person's death results within a year from his shooting at a chicken with intent to steal it. The intention to steal makes the accidental death murder. Here man is held responsible for the final results of his criminal intention in just about as far reaching a manner as if he had inflamed another who

then went out and murdered a complete stranger. Responsibility for the actions of another under certain circumstances, has been established. The Court of Appeals of New York State has recently awarded damages to an employee who when reprimanded by his foreman for negligence called the foreman a liar, and was struck and knocked down by the foreman. His glasses were shattered and vision in one eye destroyed. It was held that the employer should be held responsible for an excitable and violent foreman in the prosecution of his duties as such, at least until there is sufficient interruption in the performance of such duties as to justify the conclusion that the foreman had abandoned his employment and that the assault was an independent and individual act, as distinguished from acts within the terms of his employment.

In connection with the Espionage Act the Attorney General's Department opposed the proviso that "anti-war utterances or propaganda would not be punishable if made with good motives and for justifiable ends" on the grounds that it would make it difficult to prosecute and convict. Regulation according to this view must be in terms of actions, and motives can not be considered. Twenty-two states have adopted the Printers' Ink Statute regulating dishonest advertising in which no reference to motive or intention is made. Sixteen other states have, however, inserted the word "knowingly" or its equivalent, thus making it necessary to prove that the dishonest advertising was intentional. Legal action in these sixteen states is based primarily then upon the motive, not the act.

The 1918 Report of the Attorney General states the policy of that department regarding the enforcement of the Espionage Act. It is of significance here. One paragraph reads as follows:

"The Department throughout the war has proceeded upon the general principle that the constitutional rights of free speech, free assembly and petition exist in war time or in peace time, and that the right of discussion of governmental policy and the right of political agitation are most fundamental rights in a democracy. It has endeavored to adhere to the principle that neither the Government nor any group or class of citizens should be permitted to take advantage of the war situation to suppress discussion and agitation of domestic problems, whether political, social, economic, or moral. At the same time, however, it has held to the view that neither under the guise of political theory, social conviction, or religious creed should any man or group of men be permitted to indulge in propaganda which has the deliberate purpose of disintegrating our strength in the war or which is of an essential nature necessarily producing that effect."

In other words, the policy outlined here maintains that the welfare of the nation is paramount and that any propaganda which can be classified as injuring the national war program will be condemned regardless as to how this propaganda could be classified in terms of rights of free speech, free assembly and the like. And further that motive is of little consideration in comparison with an overt act.

So far we have considered the possibilities of controlling propaganda from the two aspects: first, as to whether the statements in it were true or false; and second, as to whether the proposed action was socially worth while or not. This discussion has seemingly emphasized the necessity of taking motives into account. Now let us consider the third aspect of the subject—the element of aroused desire, the emotional background and psychologically true cause of the action.

We have seen that theoretically any emotion may be aroused as the basis for stirring one to act and that there needs be little or no rational connection between the two. The detailed suffering of a little girl and her kitten can motivate our hatred against the Germans, arouse our sympathy for the Armenians, make us enthusiastic for the Red Cross, or lead us to give money for support of a home for cats. The story may be true or concocted for the purpose; the inferences against the Germans or for the home for cats may be also true or false; the organization carrying on the propaganda may be efficiently administered or not—all these considerations little concern us. We feel the emotion, we want to do something because by acting we will feel better, and away we go regardless of mere intellectual considerations.

Here is the real psychological problem concerning propaganda. Take away the emotional element and society need have no fear of propaganda. For man is always very slow to act in terms of ideas alone. Witness his indifference when he really knows the political organization in control of his municipality is flagrantly dishonest. He does nothing until his emotions are aroused by a whirlwind speaker, or by personal injury. So long as a radical writes or speaks in a philosophical manner society can rightly be indifferent. But when he discards the intellectual aspects of his views, seizes upon some slogan and fills his writings or speeches with concrete tales of human suffering and the arrogance of the rich, society rightly becomes alarmed. For now the radical is setting fire to dynamite and neither he nor any one else can tell what may result.

At the present time the prospects do not appear over bright of controlling propaganda through regulation. There is, however,

a method of weakening its influence, and that is by fighting one propaganda by another, or by general publicity. The trouble, however, with fighting bad propaganda by good propaganda, aside from the very practical consideration that the former is usually better equipped financially, is that seldom is the public supplied with facts upon which a real conclusion can be thought out. Instead it is inflamed to take sides and a deadlock results, or the matter is settled by some sort of resort to force. Just in this way arose the turmoil about the League of Nations program. Instead of thinking it through and arriving rationally at a real conclusion, Wilsonites and anti-Wilsonites became emotionally aroused and it was voted down because the latter group had the greater force measured in votes. Both sides know the real issue is not dead, and the Republicans who defeated Wilson's program are now attempting at Washington to find the conclusions we should have reached months ago. Fighting propaganda with propaganda is not likely, then, to give us satisfactory results.

Can propaganda be controlled through publicity? Yes, if we had perfect publicity. But that, apparently, we cannot have. Hence, we can only hope to have partial control by this means.

It has been suggested that propaganda could be controlled by national control of all publicity. Would such regulated and censored publicity help here?

The two extremes of publicity are no freedom of speech and complete freedom to say whatever one wants to. The Anglo-Saxons have decided that freedom is better than no freedom. The French lean quite strongly to centralized control of all publicity. Observers both from within and without that country testify that such censorship deadens public interest in the news of the world. And it certainly makes possible all manner of mouth-to-mouth whisperings—the most insidious and undermining of all propaganda. An editorial in the New York Times only the other day called attention to the marked difference in behavior of radicals in this country and abroad concerning Sacco and Vanzitti, who have been condemned to the electric chair for murder. Abroad the Reds have inspired the rank and file of their group with rage over the so-called persecution by the American Government of those radical leaders and several assassinations have been attempted as a result. In this country no such disturbance has resulted because, as the Times points out, everyone is familiar with all the facts of the case and so even the Reds can not be stirred up over the affair.

Possibly publicity is the one best cure we have to-day for handling those forms of propaganda which are not readily con-

trolled by other means. But if this is the case it means that more of our newspapers and magazines will have to convince the public that what they print is not controlled by certain interests. At the present time I should judge that great numbers of citizens believe most newspapers, if not their own, distort the facts to fit their purposes. And again, if publicity is to cure the evils of propaganda, it means that society must work out some more satisfactory method than now exists of providing the groups of poor people with adequate publicity to offset the enormous advantage that groups composed of wealthy people have in commanding the printed page. Too few newspapers print to-day, and too few can ever afford to print, the detailed testimony in a labor controversy, yet unless the laboring man feels his side is presented, he will have supplied to him and will read wild denunciations of capital instead of the sworn testimony of his leaders as given before a board of arbitration.

Another means of controlling propaganda lies in educating the public to an understanding of the methods employed in propaganda. It is thought that man likes to feel he is being appealed to on logical grounds: that he resents being "soft-soaped." And that he does not want to be "worked," or to have something "put over on him." Possibly, it is contended, articles such as have appeared recently in our magazines recounting the methods by which propagandists have fooled men and women may educate the public to see through a publicity campaign. Personally, I do not believe that very much can be accomplished in this way, for, as Barnum claimed, the public likes to be fooled; and secondly, clever appeals to the emotions will nearly always win when pitted against intellectually held convictions.

In closing, I want to emphasize one point. It is possible to-day for a group to carry on a very subtle propaganda with the immediate aim of developing some sentiment. There is no machinery to stop them, whether the sentiment is socially good or bad. For sentiment is an emotional state of mind and as long as no action results, society to-day has no way to handle it. So France mourned at the Strasbourg statue in Paris each year and kept alive the sentiment to retake Alsace-Lorraine. Of course, we completely sympathize with her. But it made Germany prepare all the more for war. And the world sat back and looked on while Germany established the sentiment in the minds and hearts of her citizens that they lived only for the fatherland and that war was the truest expression of their country's life. The Grand Army of the Republic and the Confederate Veterans have perpetuated northern and southern antipathies and the American Legion must of neces-

sity keep us antagonistic toward Germany. For these organizations are surcharged with emotion. General O'Ryan is quoted in the papers as follows:

"Ten years from now the battlefields of Europe will not look as they appear to-day. They will bear monuments of men on horseback and the young men will grow up thinking of war in terms of medals, glory and men on horseback rather than in terms used by the young men of to-day who were in the war. Delay in solving this problem will mean that those who profit by war will get control of the kids and that's what they want. The youngsters will be hypnotized to believe anything in the name of patriotism and they will want to get medals and glory of their own."

If war is to be eliminated, it will be necessary to control the sentiments that are developed in each and every country. Similarly if peace is to be attained between capital and labor, the right sentiment will have to be developed. Many an employer has been smarting under conditions now past when labor had the whip hand. He is now getting even, as he says. He is reacting to a sentiment of revenge and at the same time building up a similar one in the minds of his employees. This is the sure road to worse conditions.

As far as I can see, society has reached the point in its development when it must take motives into account, because man has now learned how to arouse motives to action in an economical and wholesale way. And in regulating motives society must come to evaluate the sentiments that propaganda is aimed to create, and to regulate in some way the use of phrases arousing emotions, as distinguished from phrases appealing to rational consideration. Without control in some way of the emotional element in propaganda, legal action will never stop the most dangerous of propaganda which arouses a sentiment first of all and then at the proper moment in one fell swoop precipitates that sentiment into action.

PUBLIC HEALTH AND EXPERIMENTAL BIOLOGY

By Professor HARRY BEAL TORREY

UNIVERSITY OF OREGON

I

LAST October, in the library of the College of Physicians in Philadelphia, I came upon a letter from Lord Lister to Dr. W. W. Keen. It was dated 4th April, 1898. It began as follows:

12 Park Crescent, Portland Place, London W.
4th April, 1898.

My Dear Sir:

I am grieved to learn that there should be even a remote chance of the legislature of any state in the Union passing a bill for regulating experiments on animals.

It is only comparatively recently in the world's history that the gross darkness of empiricism has given place to more and more scientific practice; and this result has been mainly due to experiment upon living animals. It was to these that Harvey was in a large measure indebted for the fundamental discovery of the circulation of the blood. And the great American triumph of general anæsthesia was greatly promoted by them. Advancing knowledge has shown more and more that the bodies of the lower animals are essentially similar to our own in their intimate structure and function; so that lessons learned from them may be applied to human pathology and treatment. If we refuse to avail ourselves of this means of acquiring increased acquaintance with the working of that marvelously complex machine, the animal body, we must either be content to remain at an absolute standstill or return to the fearful haphazard ways of testing new remedies upon human patients in the first instance, which prevailed in the dark ages. . . .

My own first investigations of any importance were a study of the process of inflammation in the transparent web of the frog's foot. The experiments were very numerous and were performed at all hours of the day in my own house. I was then a young unknown practitioner; and if the present (English) law had been in existence, it might have been difficult for me to obtain the requisite licenses; and even if I had got them, it would have been impossible for me to have gone to a public laboratory to work. Yet without these early researches which the existing law would have prevented, I could not have found my way among the perplexing difficulties which beset me in developing the antiseptic system of treatment in surgery.

In the course of my antiseptic work at a later period I frequently had recourse to experiments on animals. One of these occurs to me which yielded particularly valuable results, but which I certainly should not have done if the present law had been in force. It had reference to the behavior of a thread composed of animal tissue applied antiseptically for tying an arterial

trunk. I had prepared a ligature of such material at a house where I was spending a few days at a distance from home; and it occurred to me to test it upon the carotid artery of a calf. Acting on the spur of the moment, I procured the needful animal at a neighboring market; a lay friend gave chloroform and another assisted at the operation. Four weeks later the calf was killed and its neck was sent to me. On my dissecting it, the thread, instead of being thrown off by suppuration, had been replaced under the new septic conditions, by a firm ring of living fibrous tissue, the old dangers of such an operation being completely obviated. . . . .

At the very time that I was reading these words, twenty-two years after they had been written, *The Country Gentleman* for October 16, 1920, was carrying broadcast over the United States an article entitled "Vivisection" by an antivivisectionist, which after exhibiting the grossest ignorance of the purposes and practices of contemporary investigators who use animals in their experiments concludes as follows:

Alienists—Doctor Bishop and various others of high standing—have taken a further step than the mere plea of needless cruelty in their arraignment of vivisection.

They claim that vivisectors are not actuated by any scientific zeal, but are mental degenerates. In other words, that vivisection is a recognized form of mental perversion—a savage mania which is known to the keepers in every mad house. It is of the same order as the spirit which incites murderers of a certain type to rip their human victims' bodies to pieces. ! !

The author is obviously irresponsible, and his work would be negligible were it not for the fact that it receives official endorsement. On the editorial page, under the caption "Vivisection," cognizance is taken of the statement already quoted, in an editorial which is essentially a brief abstract of the article ending with these words:

Other doctors, here and in Europe, go a step further, by declaring that cases of a recognized form of mental perversion are known among vivisectors. The public should understand this vivisection argument from both sides. The accompanying article supplies such needful information in a way to prove antivivisection's case.

My attention had been attracted originally to this number of *The Country Gentleman* by editorials in two eastern newspapers that were disposed to be sharply critical of the appearance of this propaganda on the eve of the November election in California where an antivivisection measure was on the ballot.

The motive prompting the appearance of the article at that time need not concern us. The charges implied in the editorials to which I refer have been officially denied, and I am glad to accept the denial. Indeed, it should be said that on February 12 *The Country Gentleman* printed a very able defense by Dr. W. W.

Keen of what he very properly calls experimental research. It even introduced with kind words the widely known and respected author. Its editorial columns are, however, silent. This silence after Dr. Keen's admirable exposition of the facts contrasts significantly with the warm editorial endorsement of the October article, in which one looks in vain for the slightest first hand knowledge of contemporary experimentation.

Yet *The Country Gentleman* is published in Philadelphia. The Saturday Evening Post, published by the same company, was founded by Benjamin Franklin, the same Benjamin Franklin who was one of the founders of the Philadelphia Hospital in which the students of the first school of medicine to be founded in the United States were taught by its first professor of clinical medicine. From that time Philadelphia has been a great seat of medical learning. Two of our best medical schools now flourish there. On the roster of the College of Physicians are many of the most illustrious names in the medical history of the last century and a half. Its wonderful library is said to be surpassed in this country only by that of the Surgeon General's Office in Washington.

II

There is no need to dwell further on this remarkable exhibition of opposition to a principle which has not only been repeatedly established in fact, but has recently been ratified by a decisive majority at the polls. California is free, for the present at least, to safeguard the health of its people by the necessary research.

What part may experimental biology be expected to play in this connection?

An answer to this question will depend first upon what we may consider experimental biology to be. As I think of it, its limits are set by no group of organisms nor by any circumscribed body of facts. The field of experimental biology is the living world. Its materials are omnipresent there. Its problems are general, fundamental problems of organisms, carried to the limits of human interest. Its method is analytical. Its object is the discovery of mechanisms, processes, dynamic relations. I like to think of it as an attitude of mind rather than a department of biological knowledge. For there is no department of biological knowledge that may not reveal this interest in the fundamental problems, dynamic relations, and analytic methods which to my mind characterize experimental biology.

What is the relation between experimental biology, thus conceived, and the public health?

Health is a name we apply to a standard of mental and physical

fitness that varies with our enlightenment and our individual necessities. This standard is maintained by both private and public agencies. Private agencies are concerned primarily with individual cases involving some form of treatment. This treatment may be: (1) applied by the individual himself when in control of the necessary means, as provided, for instance, by the rules of personal hygiene or athletic training; or (2) applied by an expert upon whose superior skill or insight he temporarily relies.

These experts form a heterogeneous assemblage, including such different elements as masseurs and physio-therapists, physical directors, physicians and surgeons and all others who may be licensed by law to render professional services under definitely prescribed conditions. This heterogeneity raises many perplexing practical problems, which however, need not detain us here.

While private agencies are concerned primarily with the problems of private individuals, public agencies are concerned primarily with the interests of the public as a whole, especially with those sources of danger whose control demands collective as against individual effort. The general method of the public agencies is *prevention*. This we are accustomed to contrast with *treatment*, the traditional method of the private agencies. These methods in certain respects, do contrast sharply with each other. Where prevention succeeds, treatment becomes superfluous. And in so far as private practice is dependent upon the treatment of preventable disorders, its function is temporary only—of the nature, let us say, of emergency service. But it must be recognized that treatment may be essentially preventive in nature, and is becoming more and more so, as old-fashioned prescription writing is displaced by the instruction of patients in the care of their bodies and the avoidance of disease. The functions of private and public agencies are thus entirely compatible. No reputable physician will prolong treatment for his own profit, nor will he hesitate to make it unnecessary if he can. Though worthy of his hire, he is nevertheless a public servant. Under no other theory can the state appropriate the sums it does for his professional training. It is his duty to destroy disease and develop a sturdy race just as it is the duty of the teacher to dispel ignorance and encourage resourceful, self-reliant minds. His is a double function: to cooperate with public agencies in preventive measures and to care especially for those whom such measures have failed to protect.

So much for the relation of public and private agencies. From whatever angle the problems of health may be contemplated, they are scientific problems. They are also fundamentally biological problems, of a sort to invite an experimental method of attack.

III

The problems of public health center about the control of the causes of disease. Disease may be defined as a more or less radical departure from a standard of bodily or mental health, variously determined, which may be taken as a standard of reference. It is a relative term, in no sense a definite entity. Thus defined, it has a variety of causes. Some of these are well known, and form the basis of the public health work of the present day. Some of them—how many we cannot say—are quite unknown. It is toward the discovery and control of these that experimental biology may be expected to make its chief contributions to the health of the future. Accordingly I shall attempt to gain space for the discussion of these problems of the future by avoiding more than a summary reference to the conquests of the past.

These conquests were largely initiated by Pasteur and a few of his contemporaries. The mysteries of suppuration vanished in the light shed by his experimental studies on fermentation. And contagion received its clear explanation in the demonstration of the transportation of an infecting organism by some appropriate carrier from one host to another. Thence arose a dominant motive in prevention, the discovery and eradication of pathogenic organisms and their means of dispersal—by fumigation, quarantine, sanitation, destruction of breeding places, and carriers and their breeding places, and so on. New organisms are being almost daily discovered—witness the organism of yellew fever recently isolated by Noguchi, and many additions to our knowledge of the intestinal fauna to which Professor Kofoid and his co-workers have made such notable contributions.

When it is not possible to prevent infection, the same result, since Pasteur, may be achieved by immunizing the host with specific antitoxic sera and vaccines of various sorts.

When neither contagion can be prevented nor immunization effected, it is naturally sound practice to discover the infection at the earliest possible moment. This is one reason for such agencies as public health nurses and public dispensaries.

Education in hygiene is another means of prevention—efficacious both against infectious diseases (*e. g.*, tuberculosis) and those lapses from health that are referable to other causes connected with the customary mode of life, such as bad housing, dangers of occupation, unsatisfactory food and clothing, and so on.

With this sketchy summary of public health activities as they are commonly practiced, we may turn to certain aspects of the general problem which have for the most part a future signifi-

cance. First, let us consider the group of psychopathic disorders. These are due to a variety of causes, among which are defective inheritance, syphilis, alcoholism, accidental injuries, social including occupational maladjustments, sex maladjustments, defects in education, especially early education. The first may be controlled by prevention of propagation, and in severe cases in no other way, as has been established by studies in heredity. The manner of prevention is open to question. Segregation of the sexes is entirely possible, but presents some practical difficulties at the present time. Sterilization laws are in effect in a few states. But the recent experimental results of Steinach throw some doubt upon the all-round efficacy of the usual method of vasectomy. In the tests of rats whose *vasa* had been ligated, the sex cells degenerated; but the interstitial tissue hypertrophied with a corresponding augmentation of the sex impulse. It is obvious that such an operation, effective though it may be as a method of sterilization, is of questionable protection for the public against a potential rapist and carrier of venereal disease. Further experiments are needed.

Spyhilis continues to resist all methods of prevention, but infections are subject to control as a result of the experimental investigation of Schaudinn, Metchnikoff, Ehrlich and others; that complete cures are effected, however, has still to be demonstrated.

Alcoholism is—theoretically—preventable by law. There can be no question of the salutary effect of even our present degree of prohibition upon the prevalence of venereal disease and the milder psychopathic cases, as well as crime and poverty. As a cause of degeneracy Pearson's well-known statistics are supported, on the one hand, by the performances of Pearl's alcoholized fowls, and opposed, on the other, by Stockard's degenerate guinea pigs which continued to reappear for several generations after one ancestor, a male, had become an involuntary victim of alcoholism. Whether the present law in the United States represents a position of biological stability can not be determined until further careful experimentation produces more, and more varied, data on the physiological effects of alcohol on the human mechanism as a whole.

Social and occupational maladjustments, though often apparent to casual inspection, offer to the nerve physiologist and psychologist a multitude of subtle problems in abnormal human reaction that have hardly begun to receive proper attention, important though they appear in the analysis of psychopathic cases.

Sex maladjustments, further potent sources of ill health, present another array of problems to the student of nerve physiology and the endocrine organs and their inter-relations, that have so far been merely reconnoitered.

Finally, the education of early life provides large opportunity for the crossing of reflexes in tangled patterns that exert a warping influence upon normal behavior. Here is a field for both biological experimentation and the prophylaxis of biological instruction. We hold our young too cheap. To develop with careful teaching their natural interest in themselves and the normal processes of organic nature, is to provide insurance toward a normal life.

In a second group of disorders that from the increasing frequency of their incidence and their obscure causation are of distinct public concern, I have placed the malignant tumors and the affection of the endocrine glands.

Time will not permit me to dwell upon the grave seriousness of the problems they present, and the great opportunities they afford for experimental analysis.

Similarly it will not be possible to consider further the subject of eugenics, which has already been touched upon in connection with psychopathic disorders.

The few illustrations that have been cited will suggest something of the place of experimental biology in the medical research of the future.

IV

In closing I would like to tell you of two education experiments that are being made in Oregon bearing on the present subject of discussion. The first is the introduction of elementary biology into the school systems of three cities of the state. The courses are planned for the third to eighth years (inclusive) of school life. They are in charge of specially trained teachers who are undertaking to teach the subject as science and encourage the experimental method. The results for the past year are everything that could be wished. The children are enthusiastic, and have carried the infection of their interest to other classrooms and to their homes. The wide-ranging observation, initiative, inventiveness, keen criticism and clear thinking of these eight-to-ten year olds have astonished and pleased parents and school authorities alike.

The course covers the whole field of biology. One of its objects is to provide a natural, unconscious and authentic approach to the problems of adolescence. To one who has waited many years for the establishment of such instruction, the admirable teachers' reports embodying its first fruits read like fairy tales. I suggest it as a serious experiment in mental and moral prophylaxis.

The second project to which I have invited your attention is a seven year course in medicine. The student who enters the univer-

sity with the intention of studying medicine enrolls at once as a student of medicine, in a curriculum that extends without break through the seven years of formal instruction preceding the assumption of his professional degree.

The prime object of this curriculum is the fusion of those phases of medical education that are customarily known as the work of the pre-medical, pre-clinical and clinical years into a single organic whole. By this means it is hoped

(1.) To introduce students early to medical problems that they may see the very practical connection between their basic work and ultimate professional success—avoiding, however, the serious error of permitting the substitution of the superficial drama of the clinic for the fundamental scientific knowledge on which their later clinical success must rest.

(2.) To stimulate intensive cultivation of the medical sciences, biology, chemistry, physics and psychology, by means of which to continue indefinitely to live in the present of medical achievement—to quicken especially the spirit of research.

(3.) To indicate that medicine is beyond all things a calling that makes demands on every human resource—on all the fullness of experience, the ripeness of wisdom, the subtle understanding of men.

4.) To make every student of medicine wise and skilful in the technic of his profession.

(5.) To make him a public-minded citizen, thoughtful of his community, jealous for its future.

It may be said further that a department of experimental biology has been added to the traditional subjects provided by law for medical schools, and a directorship of research in fundamental medical science with functions extending throughout the entire seven year course.

These are concrete expressions of the view that has been here supported—that medicine has a biological foundation and with the public health must needs prosper on biological research.

THE CONSERVATION OF THE MAMMALS AND OTHER VANISHING ANIMALS OF THE PACIFIC

By Dr. BARTON WARREN EVERMANN
MUSEUM OF THE CALIFORNIA ACADEMY OF SCIENCES

AT the Pasadena meeting of the Pacific Division of the American Association for the Advancement of Science two years ago, the writer presented a paper on the "Scientific and Economic Problems of the Mammals and Birds of the North Pacific." In that paper attention was called to the inadequacy of our knowledge of the distribution, abundance and habits of even the most common species of marine mammals of the North Pacific. We know only approximately what the species are. There may be 44, as given in the most recent lists, or there may be more or not so many; we do not know with any certainty.

Excepting the fur-seal, our knowledge of the various species is very incomplete. We know the fur-seal fairly well, but not completely in all its aspects by any means. Much has been added in recent years to our knowledge of certain of the whales, through the investigations of Dr. Roy C. Andrews, but of others little or nothing has been learned since Scammon in 1870.

In the paper referred to, attention was called to the richness of the North Pacific as a field for scientific investigation and some of the problems were mentioned. The commercial or economic necessity for an immediate study of some of these problems was urged. At the Pan-Pacific Scientific Conference held at Honolulu in August, 1920, he again called attention to this matter and expressed the hope that some cooperative arrangement might be perfected whereby the various countries bordering on the Pacific might jointly undertake such investigations.

During the last three years, through the cooperation of the California Sea Products Company of San Francisco, a considerable amount of very interesting and useful data has been assembled regarding the whale fishery on the California coast, but we do not yet know even approximately well the life history of a single species of those great animals.

The whales are only one illustration of the incompleteness of

our knowledge of the animals of the Pacific. Even our knowledge of the fur-seal, about which more has been written than about any other animal (man excepted) in the world, is still incomplete in several very important respects. We know only a trifle about the sea lions, harbor seals, walrus, elephant seal, the porpoises and the sea otter. Much remains to be learned concerning the life history of the halibut, the herring, the tuna and the sardine, before we can formulate laws for their proper utilization and conservation. We are only now, chiefly through the painstaking investigations of Dr. Charles H. Gilbert, beginning to understand what must be done to save the salmon fishery and make it a going concern.

Most of the animals mentioned, as well as many others about which we know little, are of wide distribution and their effective study and conservation can be brought about only through international cooperation. And this brings us to a consideration of the nature of the cooperation that will be most effective, and the ways and means by which it may be brought about.

It is now desired to offer some suggestions upon this phase of the subject and to call attention to a few of the problems of most pressing moment.

In the first place, it must be realized that these problems, certainly many of them, are international in their scope, and not limited in their relations merely to two or three of the most important countries concerned; that mistake was made by the United States in the fur-seal treaties.

When the Paris Tribunal was formed in 1892, the United States and Great Britain thought they were the only countries seriously concerned. This view was no doubt based upon the fact that only their citizens were, or had been up to that time, engaged in pelagic sealing. The vital mistake made was the assumption that other countries were not likely sooner or later to go into the business.

Up to that time, it is true, no other country had seriously engaged in killing fur seals in the open sea of the North Pacific; even the Japanese had not yet done much, if any, pelagic sealing.

The Japanese government was anxious to join the United States and Great Britain in the treaty of 1892, but her advances were not encouraged. And what was the result? Japan immediately embarked with great vigor in the vastly remunerative and extremely fascinating sport of killing seals in the open sea. Not being bound by the Paris Tribunal regulations, Japan could lawfully kill seals at any time and anywhere in the ocean, even right up to the 3-mile limit around the seal islands and along the American coast. So vigorously did the Japanese carry on this business, and so defective in other respects were the regulation of the Paris

Tribunal, that the Alaska fur-seal herd steadily and rapidly decreased from 402,850 seals in 1897 to 127,745 in 1911.

A new fur-seal treaty was negotiated in 1911, the participating countries being the United States, Great Britain, Russia, and Japan. The United States and Great Britain had at last learned that the problem did not concern them alone, so Japan and Russia were permitted to come in. But who knows how soon some other countries may not be tempted to engage in pelagic sealing? In 1911, our fur-seal herd had become reduced to about 127,000 seals. Under the protection of the present treaty it has increased to more than 550,000. Very soon fur-seals will be so abundant in the North Pacific as to promise great profits to adventurous spirits who may be tempted to engage in pelagic sealing; indeed, it is thought some pelagic sealing has already been going on in the last year or two. What is to prevent them from outfitting in China, Mexico, Peru, Chile, or other countries bordering on the Pacific, sailing under the flags of those countries, and again endangering the existence of the fur-seal herd? Any of those countries has a perfect right to engage in the business if it wishes to do so. The only question they need to consider is whether it can be commercially profitable. And the rapid increase of the herd gives the answer to that question.

The present treaty became effective December 15, 1911, and runs for a period of 15 years. It seems to be fairly well observed, and the herd, although some pelagic sealing has apparently been going on, and in spite of some mismanagement on the islands, has increased rapidly. By 1926, when an opportunity will be afforded to revise the treaty, or even to withdraw from it if any of the signatory powers should wish to do so, the herd will probably contain not fewer than 1,000,000 seals.

It can be assumed, I think, that the treaty will be continued in 1926. The opportunity then afforded should not be neglected to invite all countries bordering on the Pacific and any and all others ever likely to become interested in pelagic sealing, to become parties to the treaty.

The opportunity to correct certain other defects in the present treaty should be taken. For example, under the present treaty, the aborigines on the coasts of the United States, British Columbia, Alaska, Japan and Russia, are permitted to kill seals in the open sea and along their shores. This is a very unwise provision, in that it permits the killing of female seals which has always been regarded as the most objectionable feature of pelagic sealing. The number of seals killed every spring by our Indians on the coasts of Oregon, Washington and Alaska, and by those on the coast of

British Columbia, is already great and is increasing every year. Granting this concession to the Indians or other aborigines is unwise and unnecessary and should be withdrawn.

Cooperation in a Study of the Problems of the Pacific

Steps have already been taken looking toward cooperation among bodies of scientific men of the countries bordering on the Pacific for the purpose of investigation and study of the scientific problems of the Pacific. The Pan-Pacific Scientific Conference which was held at Honolulu in August, 1920, devoted most of its time to discussion of these problems and to consideration of the method of attack.

The National Research Council, established in 1916 under the Congressional Charter of the National Academy of Sciences and organized with the cooperation of the national scientific and technical societies of the United States, has taken cognizance of the matter. In the Council's Division of Foreign Relations has been formed a Committee on Pacific Investigations, which has already begun consideration of the preliminary problems involved. Evidently, one of the first questions to consider is that of the nature of the cooperation that will avoid embarrassing entanglements, and which will bring results.

The National Research Council, through its Division of Foreign Relations, has already addressed letters to similar organizations or bodies of scientific men in several of the countries bordering on the Pacific, inviting them to cooperate with the Committee on Pacific Investigations in a study of the problems of the Pacific of broad or international interest. It is understood that favorable replies have been received from various countries addressed. The exchange of views expressed by the biologists, geologists, meteorologists, oceanographers and others at the Honolulu Conference last year showed clearly that the scientific men of the Pacific area are alive to the importance of the scientific problems of the Pacific and to the necessity of cooperation in their study. The replies received by The National Research Council abundantly bear out the same conclusion. The time, therefore, seems opportune, for consideration of ways and means.

Method of Cooperation

The problems to be studied are so many, so large, and so complex, that their solution can not be brought about in a day. They will require time and money. Whatever may be the character of the organization at the beginning, it is more than probable that the work must sooner or later depend upon government patronage.

It is doubtful if this could be secured until after a campaign of education has been carried on. The holding of the first Pan-Pacific Conference at Honolulu last year, under the patronage of the Pan-Pacific Union, did much to develop public and government interest in the matter. Other similar conferences that may be held perhaps in the near future, in Japan, New Zealand or Australia, and perhaps in America, would prove very effective in increasing this interest. The Pan-Pacific Union would, in all probability, be glad to act as host and provide the funds to meet all necessary expenses. These conferences would almost certainly result in the taking up of certain more or less local investigations by local scientific institutions or bodies of scientific men.

When the governments see what private and institutional agencies are doing, they will begin to realize that some of these investigations can be carried on only with government aid and international cooperation. Then the time would be ripe for effecting an organization for the study of the scientific problems of the Pacific, something like The International Council for the Exploration of the Sea.

In the meantime, it would help greatly if the various scientific agencies on the Pacific Coast of America could unite in some sort of a cooperative organization to study some of the important and pressing problems right at their doors. Among the problems that concern us here on the American coast the following may be mentioned:

(1.) The Gigantic Tortoises of the Galapagos Islands. Fifteen species of these wonderful animals are known from those islands. Some are already extinct; others are certain of very early extinction unless steps be taken very soon to protect them.

(2.) The elephant seal of Guadalupe Island should be looked after at once. It may already be too late.

(3.) The Heermann gull and other sea bird breeding rookeries on islands in the Gulf of California. The California Academy of Sciences expedition to those islands this year found eggers from La Paz, Guaymas and other places at the islands gathering the eggs as fast as they were laid and taking them for food. Only a few years of such practice will prove fatal to the breeding rookeries of these interesting birds.

(4.) The sea turtles of the Gulf of California and the west coast of Lower California are in great danger of extermination.

(5.) The sea lions and harbor seals from the Gulf of California to Bering Straits need careful study. We do not yet know sufficiently well their relation to the fisheries.

(6.) The sea otter, now nearly extinct, should receive immediate attention.

(7.) The whales of the Pacific supply one of the most important and urgent fields for investigation.

(8.) The salmon, halibut and herring of our northern coast present a number of problems of mutual interest to the United States and British Columbia.

(9.) The tuna and other migratory fishes of the southern California coast.

(10.) The walrus of the North Pacific is being rapidly and ruthlessly destroyed.

Each and all of these present problems require for their investigation and solution the cooperation of two or more American countries.

There are on the Pacific Coast of America more than a score of scientific and educational institutions as well as numerous commercial and social organizations, and hundreds of scientific men that should be interested in the study and conservation of these animals.

It ought not to be difficult to bring about some sort of an organization of all, or at least a considerable proportion of these various units to work unitedly for the conservation of these vanishing natural resources. Such an organization, working through committees, would carry great weight with the several governments concerned and should in time be able to accomplish important results.

It would seem that this is an opportune time for taking the initial steps for bringing about the cooperation necessary for a study of these problems. With this object in view the following resolution has been offered:

Whereas, Our knowledge of the habits, distribution, and abundance of the marine mammals, certain species of food fishes and other interesting and important animals occurring on the Pacific Coast of America, is not adequate as a basis for the formulation of laws and regulations for their conservation and proper utilization, and

Whereas, There is reason to believe that several of these species will in the near future become extinct unless measures are promptly taken for their preservation, and

Whereas, The problems involved are such as concern the several countries of America bordering on the Pacific, now therefore be it

Resolved, That a committee of five, representing the Pacific Division, American Association for the Advancement of Science, be appointed by the president to take up with the committee on Pacific investigations of the Division of Foreign Relations of The National Research Council, the question of effecting an organization of the institutions and biologists of the American countries bordering on the Pacific for the purpose of formulating and carrying out a comprehensive plan for the scientific study of the mammals, birds, fishes,

reptiles, and other marine animals of the Pacific coast of America now threatened with extinction.

Note.—The above resolution was unanimously adopted by the Pacific Division of the American Association for the Advancement of Science at its meeting at Berkeley, California, August 4, 1921. President George E. Hale at once appointed the following as members of the Committee:

Mr. Norman B. Scofield, of the California Fish and Game Commission;

Professor Edwin C. Starks, of Stanford University;

Captain W. C. Crandall, of the Scripps Institution for Biological Research;

Dr. Walter P. Taylor, of the U. S. Bureau of Biological Survey;

Dr. Barton Warren Evermann, of the California Academy of Sciences, as chairman.

Dr. Hale has recently authorized the enlargement of the committee and the following have been added:

The committee has been organized and is now formulating the problems to be taken up and the method of procedure. It is believed that it will be able to accomplish much for the conservation and proper utilization of the marine life of the Pacific.

Mr. W. E. Allen, Scripps Institution for Biological Research, La Jolla, Calif.;

A. W. Anthony, Museum San Diego Society of Natural History, San Diego, Calif.;

Professor William A. Bryan, Museum of History, Science and Art, Los Angeles, Calif.;

Dr. Harold C. Bryant, Museum of Vertebrate Zoology, Berkeley, Calif.;

Professor John N. Cobb, College of Fisheries, University of Washington, Seattle, Wash.;

Dr. C. McLean Fraser, University of British Columbia, Vancouver, B. C.;

Dr. G. Dallas Hanna, California Academy of Sciences, San Francisco, Calif., Secretary;

Dr. Harold Heath, Stanford University, Calif.;

Dr. William E. Ritter, Scripps Institution for Biological Research, La Jolla, Calif.;

Mr. Alvin Seale, Steinhart Aquarium, California Academy of Sciences, San Francisco, Calif.;

Dr. F. B. Sumner, Scripps Institution for Biological Research, La Jolla, Calif.;

Mr. Will F. Thompson, California State Fish and Game Commission, San Pedro, Calif.

THE DAWN OF THE CELL THEORY

By Professor JOHN H. GEROULD
DARTMOUTH COLLEGE

HOW often it happens that a great discovery, before it finally flashes out upon the world, smoulders for a long time in men's minds, dimly understood, its full significance unfelt! So it was with wireless telegraphy, which by Marconi's great imagination and skill was transformed from a piece of laboratory apparatus, capable of transmitting electric waves across a room, into a great system, flashing messages across oceans and around the world. So it was with each of the three great biological discoveries of the nineteenth century, the cell theory, organic evolution and Mendelism. The last, indeed, as the reader knows, lay dormant during the final third of the century, ready to spring into rapid and luxuriant growth at the opening of the twentieth.

Organic evolution, it is well known, had its birth in the master mind of the great French naturalist, Lamarck, at the very beginning of the nineteenth century, fifty years before the appearance of Darwin's "Origin of Species," but probably few, even among the ranks of professional biologists, are aware that the cell theory owes its conception to the same fertile, comprehensive mind.

Probably no statement in the history of biology is more widely accepted and quoted by biologists today than that the cell-theory, *viz.*, that all plants and animals, as well as their embryonic forms, are composed of similar elementary parts, the cells, founded in 1838 and 1839 by the German botanist Schleiden and his friend, Schwann. So when the present writer first read in Lamarck's "Philosophie Zoologique," published in Paris in 1809, the following statement, he could hardly believe his eyes. "No body can possess life if its containing parts are not a *cellular tissue*,[1] or formed by cellular tissue." And further, "Thus every living body is essentially a *mass of cellular tissue* in which more or less complex fluids move more or less rapidly; so that, if this body is very simple, that is, without special organs, it appears homogeneous, and presents nothing but *cellular tissue* containing fluids which move within it slowly; but, if its organization is complex, all its organs

[1] The italics in this translation correspond to those in the original.

without exception, as well as their most minute parts, are enveloped in cellular tissue, and even are essentially formed of it."

In the introduction to the chapter on the "Physical Causes of Life," in which the words just quoted occur, Lamarck calls attention to the phenomena of organization and its development, especially in the lower animals, the consideration of which should convince the reader, he says, that (1) "The entire operation of nature in forming her direct creations [the development of the individual] consists in organizing into *cellular tissue* the little masses of gelatinous or mucilaginous matter that she finds at her disposal and under favorable circumstances; in filling these cellular masses with fluids that they are adapted to contain; in vitalizing them by setting the contained liquids in motion with the aid of subtle exciting fluids that ceaselessly flow into them from the surrounding medium."

How much more modern this sounds than the idea that those of us who are biologists at the beginning of the twentieth century are accustomed to hold regarding the doctrine of those who worked and wrote at the beginning of the nineteenth! We have been wont to think of the conception of the cell in those earlier days as being a cavity surrounded by a cell-wall that was then regarded as all-important, and here we find Lamarck declaring that the "little masses of gelatinous or mucilaginous matter," the protoplasm of later writers, organized into cellular tissue, are the essential vital elements, just as we hold to-day! Of the "subtle exciting fluids that ceaselessly flow into them from the surrounding medium," we are even to-day almost in ignorance. What Lamarck had in mind, as one gathers from reading elsewhere in the same work, was electric action. Lamarck seems to have anticipated by more than a hundred years the application of the electron theory to the cell, a field which to-day is still almost wholly unexplored.

Lamarck's conception of the mechanics of development set forth in his second essential condition of life is as follows:

> *Cellular tissue* is the matrix (literally "gangue," or vein-stone) in which all organization has been established, and through the medium of which the different organs have been successively developed by the movement of the contained fluids, which have gradually modified this cellular tissue.

The comparison of cellular tissue to a matrix or veinstone, in which the fluid living substance, energized and set in motion by forces acting chiefly from without, is gradually moulded into definite organs is not an apt simile, to be sure, from our present point of view, and yet even to-day are we able to replace it by a metaphor that would be more exact? In the conception now in vogue, however, the shaping of organs is attributed especially to the enzyme-

like action of the chromosomes, to *internal* physico-chemical phenomena which Lamarck covered under the expression movements of "fluides contenables," acted upon by subtle exciting fluids, "which ceaselessly flow in from the surrounding media." Present conceptions (Weismannism and Mendelism) lay great emphasis upon the rôle in development believed to be played by cell nuclei, which were unknown to Lamarck. Thirty years later, when Schleiden and Schwann approached the subject, cell-nuclei had been discovered.

It is worth a passing notice that in a clear and keen analysis of the differences between organic and inorganic bodies, which Lamarck states had been already discussed by M. Richerand, but to which he adds his own ideas, growth of organisms is described as being by "intus-susception," a notion that the present writer has been accustomed to regard as much more modern.

The statements thus far mentioned were taken from the first volume of the "Philosophie Zoologique." In the second, Lamarck devotes an entire chapter to cellular tissue, in which he says: "It has been recognized for a long time that the membranes that form the envelopes of the brain, of nerves, of vessels of all kinds, of glands, of viscera, of muscles and their fibers, and even the skin of the body, are in general, the productions of *cellular tissue*. However, it does not appear that any one has seen in this multitude of harmonizing facts anything but the facts themselves; and no one so far as I know, has yet perceived that *cellular tissue* is the general matrix of all organization, and that without this tissue no living body would be able to exist nor could have been formed. In a foot-note he adds, "Since the year 1796 I have been accustomed to set forth these principles in the first lessons of my course."

In the same year (1809) that Lamarck published this classic work, another great Frenchman, Mirbel, brought out the second edition of his "Exposition de la Théorie de l'Organisation Végétale." The general conclusion reached in the book was that "The plant is wholly formed of a continuous cellular membranous tissue," or stated as the first of a set of botanical "aphorisms" that he had prepared for the Musée de l'Histoire Naturelle to accompany a large and beautiful plate illustrating the finer structure of plants, "Plants are made up of cells, all parts of which are in continuity and form one and the same membranous tissue."

Mirbel was probably the most distinguished and industrious plant anatomist at the opening of the nineteenth century, and it is interesting to trace in his works the earliest stages of the development of the cell theory. In 1802 appeared his "Traité d' Anatomie et de Physiologie Végétales." Here are only the incoherent ele-

ments of a cell theory. He had not yet arrived at the idea that all plants are essentially cellular, and he regarded the cell-wall as of primary importance. Cells he found, in fungi and Fucus, in the epidermis and parenchyma of the higher plants, more abundantly in herbs than in trees, in sprouts than in old wood. The embryo was composed "almost entirely" of cell tissue. But he had not at the time discovered the origin of the *tubes* that are embedded in the deeper tissues of plants, so that this earliest version of the first "Aphorism," quoted above, then read: "Plants appear to be entirely composed of cells and of tubes, all parts of which are continuous." Tubes, however, it will be noted, were omitted from this aphorism when it appeared in 1809.[2]

How much collaboration there may have been between Lamarck and Mirbel, who was thirty-two years his junior, does not appear from evidence now at hand, except that both must have been closely associated in the Musée de l'Histoire Naturelle, but in 1809 both entertained somewhat similar views regarding the structure of plants.

As Mirbel expressed it in his letter to Treviranus included in his "Théorie de l'Organisation végétale," all plants are formed of "one and the same membranous tissue, variously modified," not of distinct and separate elementary organs existing independently and held together by interwoven tubes and fibers; moreover he laid great stress upon his observation that cells freely communicate with one another by pores.

Whether Lamarck based his more extensive generalizations, which included animals as well as plants, upon Mirbel's observations as well as upon his own, it is evident that both held in 1809 the essential features of the cell theory.

As Mirbel's first aphorism stated it, "Les végétaux sont composés de cellules, dont toutes les parties sont continues entre elles, et ne présentent qu'un seul et même tissu membraneux."

It must be recognized, however, that Mirbel laid emphasis upon the membranous cellular tissue as fundamental, rather than upon the cell as a unit. The folding and modification of this tissue during development resulted in the specialized full-grown plant. And, to Lamarck, cellular tissue was the matrix within which the organs, *i. e.*, the blood vessels, nerves, and other "tubes" are moulded by the movements of the contained fluids. The thought of both was centered upon the organism as a whole and

[2] It was not until 1832-33 that his studies on the structure of Marchantia convinced him by direct observation that the tracheæ are formed from cells, and do not constitute an exception to the rule that all plant structures are cellular in origin.

the primacy of cellular tissue. But to Mirbel's mind this tissue was membranous. Bichat had just laid the foundations of animal histology by the classification and description of tissues among which he included membranous cellular tissue, by which he apparently meant undifferentiated connective tissue. Probably this important and remarkable work influenced Mirbel. Neither Mirbel nor Lamarck apparently thought of the individual cell as the elementary unit.

The idea of the individuality of the cell, an important contribution to the cell theory, is due to Dutrochet, 1824, who set the notion forth in a book apparently very little known at present.

This is a fascinating account of his own physiological experiments on the movements of the sensitive plant, on growth movements and heliotropism in plants, and on muscular action in animals. He was also something of a histologist, though his microscopes (simple lenses of high magnification) were undoubtedly poor, and his methods of treating tissues with nitric acid and strong alkalis a bit drastic. After summarizing the then recent (1824) researches of Milne Edwards (Mémoire sur la structure élémentaire des principaux tissus organiques), who had found in the tissues of animals nothing but masses of globules (globules agglomérés) he says, "I have verified the exactness of these observations: everywhere, indeed there is found in the organs of animals only globular corpuscles, sometimes united into longitudinal and linear series, sometimes massed in a confused manner." After numerous details, which we pass over, he states, "From this we may draw the general conclusion that the globular corpuscles, which by their assemblage make up all the organic tissues of animals, are actually globular cells of exceeding smallness, which appear to be united only by a simple adhesive force; thus, all tissues, all animal organs, are actually only a cellular tissue variously modified. This uniformity of finer structure proves that organs actually differ among themselves merely in the nature of the substances contained in the vesicular cells, of which they are entirely composed."

Then, after telling of the wonderful diversity of cell organization in plants, which he believed to be greater than in animals, he exclaims, "One can not conceive how a diversity of products so astonishing can be the work of a single organ, of the cell! This astounding organ, in the comparison that can be made between its extreme simplicity and the extreme diversity of its real nature, is truly the fundamental element (pièce fondamentale) of organization; everything, indeed, in the organic tissue of plants, is evidently derived from the cell, and observation has just proved to us that

it is the same with animals." Thereupon he points out that the blood itself is a fluid tissue, capable by coagulation of becoming like other tissues. In it the corpuscles, which he regards as cells, float freely.

But closer examination of Dutrochet's work reveals the fact that the cell theory which he held rested upon an insecure basis of fact. This was due not so much to imperfect observation with imperfect microscopes as to the fact that the ultimate organic unit had not yet been accurately defined. That every bit of living matter has its spherical nucleus was still undiscovered.

It was the aim of the naturalists of that period, however, to resolve all organisms into their ultimate parts. The ultimate parts that they found were minute globules of various sizes, some cells, some nuclei, some nucleoli, some merely granules within the cytoplasm. It was unfortunately upon the observation of these diverse globules that Dutrochet based his excellent conclusions. He undoubtedly saw cells, and his figure of a segment of an arm of Hydra seems to prove that he saw nuclei, but the latter were to him "nervous corpuscles," corresponding to bodies in the cells of the sensitive plant, which, his figures suggest were probably nucleoli or chromosomes. He showed corresponding granules also in the stem of Vorticella, arranged in linear order. Possibly these were cytoplasmic microsomes; certainly they were not cells.

The fundamental ideas of Schleiden and Schwann's cell theory were thus contained in the writing of these and other writers of the previous generation, who have not been recognized as its founders chiefly because the term cell, in their minds, was loosely defined. They had not learned that a typical unit mass of living matter has a single spherical nucleus. The discovery of this fact made the establishment of the cell theory sure, and in the present writer's opinion was even more important than the work of Schleiden.

Although the nucleus had been seen and figured by still earlier writers, its general occurrence in plant cells was first recognized by Robert Brown, 1833, a by-product of his work on fertilization in orchids and milkweeds.[3]

It was this work that furnished Schleiden with his inspiration, and led to his attempt to discover the relation of the nucleus to the development of the cell, to answer the question: "How does this peculiar little organism, the cell, originate?" This question he answered to his own satisfaction, though not to ours, when he described the birth of the young cell by the appearance of a sort

[3] p. 710-713. See *References to Literature*.

of lens-shaped bud upon the surface of the nucleus, or "cytoblast," as he renamed it.

It is difficult in these days to follow Schleiden through the details of his "discovery," but it would appear that by the great solubility of cellular tissue (cell walls), when not too thick, a fact which "some physiologists ——— have felt prepared to deny," the new-born cells first float free, then become massed together and secrete about themselves new walls, in which the nucleus becomes imbedded, if it has not already been absorbed or "cast off as a useless member." This incorrect idea of the general method of formation of new cells overemphasized their freedom, and is reflected in Schleiden's oft-quoted remark of that "Each cell leads a double life: an independent one, pertaining to its own development alone; and another incidental, in so far as it has become an integral part of the plant." It is around this version of the cell theory, further elaborated by Haeckel in his conception of the organism as a cell state or cooperative colony of free citizens, that much discussion and criticism of the cell theory has centered, led particularly in the last decade of the nineteenth century by Sedgwick, 1895, and Bourne, 1896. The outcome of this and still more recent discussions has been to swing the emphasis away from Schleiden's version, founded as it was upon misconceptions of the process of the formation of new cells and ignorance of the universal fact of nuclear and cytoplasmic division, back to the point of view of Lamarck and Mirbel that, in its growth, the cellular organism reacts as a whole.

Although Schleiden did not originate the idea of the cell theory, which, as his "Phytogenesis" shows, he got directly from Mirbel and his own German contemporary, Meyen, he did good service to science by calling attention to Robert Brown's discovery of the universal occurrence of the nucleus in plant cells, and especially by stimulating his friend Schwann in the prosecution of those important and epoch-making studies into the structure of animal cells that we have so long regarded as the foundation of the cell theory.

Schwann, as the preface of his classic work indicates, evidently knew little of the ideas of the French biologists who had drawn the plans and begun to lay the foundations of the cell theory thirty years earlier. The physiologist, Dutrochet, for example (whom Schwann does not mention), while he had held the Lamarck-Mirbel cell theory, having no standard by which to decide what a cell is, had left the notion of the animal cell in that confused, almost chaotic state, in which Schwann says that he found it. Schwann does refer to an isolated observation of Turpin, who compares the

cells of the epithelium of the vagina with those of the parenchyma of plants, and of Dumortier, who had drawn the conclusion, from researches into the embryology of the snail, that Mirbel's proof of the development of plants from a single cellular tissue would not apply to animals, but there is probably little doubt that Schwann found in contemporary literature much confusion regarding the cell in animals.

The beautiful plates which Schwann has left us are a perennial memorial to his skill as an investigator and a striking demonstration of the essential features of various types of cells in animal tissues. Schwann, moreover, recognized that the egg is a single cell, though he was unable to decide whether its nucleus (germinal vesicle) is indeed a nucleus or a young cell.

Both Schleiden and Schwann were inquisitive to know how new cells are formed. They knew as little about it as did Lamarck. Schleiden's guess, that a lens-shaped excrescence forms upon the surface of a nucleus and furnishes a sort of intracellular bud from which the new cell develops, has already been mentioned. Schwann thought that their germ is a nucleolus, which, escaping from the nucleus into an intercellular, cell-producing "cytoblastema," grows by a process akin to crystallization, first generating the new nucleus and then the surrounding protoplasm.

But to follow the cell theory further would bring us beyond its dawn and to the break of day, to the time when the question that had perplexed the mind of Schleiden, "How does this peculiar little organism, the cell, originate?", was answered by the discovery of the interesting phenomena presented by the nucleus in cell-division. That discovery brought the cell theory into a new epoch, fraught with new and perplexing questions as to the nature of the forces that divide nucleus and cytoplasm, and shape the growing organism.

As we ponder upon these problems and seek to devise new experiments to solve them, we should do well now and then to turn back to the suggestive thoughts of Lamarck, who, untrammeled by some of the modern working hypotheses that tend to become crystallized in our minds as dogma, approached the great problems of life with the keen mind of a seer.

Résumé: (1) The cell theory was stated originally by Mirbel and Lamarck in 1808 and 1809, thirty years before Schleiden and Schwann. (2) Mirbel, like Schleiden, showed in 1808 that all plants are composed of cells, of cellular tissue, which he regarded as everywhere continuous, primarily membranous, and variously modified into all other plant tissues. He laid especial emphasis in the earlier years of his brilliant investigations upon cell walls,

which he believed to be porous, allowing free, though slow, circulation of the contained fluids. (3) Lamarck, a year later, 1809, extended the idea of cellular origin to include both animal and plant structures. To him, cellular tissue was the matrix in which the organs (tubes of various sorts) are shaped by the movements of the contained fluids, which he regarded as essential vital substance. (4) Both Mirbel and Lamarck thought of the organism as a cellular whole, not as an agglomeration of units. (5) Dutrochet in 1824, adopting the Mirbel-Lamarck theory, introduced the idea of cellular units as composing the animal and plant organism, but the idea of the cell-unit had not yet been standardized and made definite by the discovery of the nucleus. (6) Robert Brown in 1833 recognized the universal occurrence of nuclei in all plant cells. The idea of the cell as a unit then became definite. (7) Schleiden in 1838 extended Brown's discovery by his own investigations of plant tissues, and stimulated his friends Schwann to research into the cell structure of animal tissues. He failed to discover how new cells originate, though this was the chief aim of his classic paper on phytogenesis. (8) Schwann in 1839 made a most important contribution to knowledge of animal histology, isolating, and accurately describing and drawing, many different varieties of cells. He added to the cell theory of Lamarck, Mirbel, and Dutrochet, guided by Brown's discovery of the nucleus, a clear-cut conception of the nature and limits of the individual animal cell. His elaborate speculative comparison between the origin and growth of crystals and of cells was founded on an erroneous belief as to the origin and development of new cells out of nucleoli, but, nevertheless, contains suggestions as to the nature of growth that foreshadow some of the more recent ideas of bio-chemistry and bio-physics.

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JAPANESE INFUENCE IN CHINESE MEDICAL EDUCATION[1]

By Dr. E. V. COWDRY

Chinese Students In Japan

THE forty-fifth annual report of the Japanese Minister of State for Education, published in 1920, is an imposing volume of about four hundred pages, printed in English. It is an analysis of the activities of the department for the fiscal year 1917-1918, and clearly shows how Chinese students of all kinds come to Japan for their education. They are found from the Kindergartens to the Imperial Universities, in the technical schools, Academy of Music, Fine Art School, in the Schools of Agriculture and Forestry, of Sericulture and Filature, even in the schools for the deaf, in fact almost everywhere. In the public and private special schools 980 are studying law and politics (giving Japanese ideals a strong footing in China) as compared with 66 in medicine. In the Imperial Universities, where it is more difficult to gain admission, there are but 18 in medicine. It is quite clear from the context that the Chinese are often listed simply as "foreigners," though a very small minority of foreigners are probably Europeans. A conservative estimate would place the number of Chinese students at well over 4,500. The report, as far as it concerns us, may be summarized as follows:

Foreigners in elementary schools	71
Foreigners in public and private kindergartens	127
Chinese in Tokyo School for the Deaf	1
Chinese in Tokyo Higher Normal School for Men	79
Chinese in Hiroshima Higher Normal School	6
Chinese in Tokyo Higher Normal School for Women	7
Foreigners in normal schools	1
Foreigners in public and private middle schools	11
Foreigners in public and private higher schools for girls	1
Chinese in higher schools	154
Foreigners in Tokyo Imperial University	52
Chinese in Kyoto Imperial University	29
Foreigners in Tohoku Imperial University	17
Chinese in Kyushu Imperial University	10
Chinese in Kokyo Fine Art School	13

[1] Anatomical Laboratory of the Peking Union Medical College and the Laboratories of the Rockefeller Institute for Medical Research, New York.

Foreigners in public and private special schools	1,188
Foreigners in Tokyo Academy of Music	11
Chinese in Kagoshima Higher School of Agriculture and Forestry	10
Chinese in Tokyo Higher School of Sericulture and Filature	4
Chinese in Tokyo Higher Commercial School	24
Chinese in Kobe Higher Commercial School	14
Chinese in Nagasaki Higher Commercial School	8
Foreigners in Tokyo Higher Technical School	202
Chinese in Osaka Higher Technical School	27
Chinese in Kyoto Higher Technical School	5
Chinese in Nagoya Higher Technical School	10
Chinese in Kumamoto Higher Technical School	1
Foreigners in public and private technical schools	29
Foreigners in public and private miscellaneous schools	3,052
	4,962

Since the elementary schools maintained by the Chinese communities in Yokohama, Osaka and other large commercial centers, and some private schools, are apparently not always included, it is safe to estimate that the number of Chinese students returning home each year to enter professional or business careers is well over a hundred. During the past few years some ill-feeling has developed but there are indications that a few of the more progressive Japanese are alive to the fact that these students may be converted into ambassadors of good will between the nations. It is unlikely that there has been any great falling off in number. Detailed reports subsequent to 1917-1918 are unavailable; but Mr. Shun Ichi Ono has very kindly obtained data from the official records kept in the "Inspection Office for Chinese Students in Japan," maintained in Tokyo by the Chinese Government, showing that 199 Chinese students have registered for courses in medicine (including dentistry) for the academic year 1921-1922 distributed as follows:

Achi Medical School	14
Chiba Medical School for Women	1
Chiba Special Medical School	50
Fuji Pharmaceutical School	1
Jikei Medical School (Tokyo)	6
Keioh University Medical School	1
Kyoto Imperial University	6
Kyoto Medical School	3
Kyoto Prefectural Medical School	2
Kyoto Pharmaceutical School	4
Kyushu Imperial University	17
Mizuhara Midwifery School	1
Nagasaki Midwifery School	5
Nagasaki Special Medical School	9
Nagoya Prefectural Medical School	1

Nippon Medical School (Tokyo)	23
Okayama Special Medical School	6
Osaka Dental School	1
Osaka Prefectural Medical School	5
Tokyo Dental School	4
Tokyo Imperial University	2
Tokyo Medical School	17
Tokyo Medical School for Women	15
Tokyo Midwifery School	3
Tokyo Pharmaceutical School	2
	199

The records show that the expenses of 118 of these students are paid by the Federal or Provincial Chinese governments and that 54 come at their own expense. The means of support of the remaining 27 are not given. It is interesting to note that none of the government students attends the Imperial University Medical Schools, perhaps on account of their insufficient pre-medical training or in view of the relatively high fees. They attend for the most part the special medical schools of which Chiba appears to be the most popular, with an enrollment of 50 students. The Nippon and Tokyo Medical Schools, which also attract a considerable number, are of rather inferior grade.

The fact that 25 out of the total number of 199 students, or a little over 12 per cent. are women, is indicative of the broad-minded policy which the Chinese are adopting toward medical education for women. It is indeed a considerably larger percentage of women medical students than we find, even in the United States, where in the year 1920-1921, they amounted only to 5.9 per cent.[2] It is significant also that 9 of them are maintained by the Chinese government; but why they should be sent to Japan where the opportunities for women medical students are distinctly less favorable than in China[3] it is very difficult to suggest.

The instruction offered is fairly uniform, because, in Japan, government control is far-reaching, and the private schools are usually well-organized and systematic in the enforcement of their requirements. Judged by the "Standards of the Council on Medical Education and Hospitals of the American Medical Association," with liberal allowance for difference in local conditions, very few of the Imperial Universities and special medical schools would fall below "B" grade while quite a number would probably be granted "A" rating. From our point of view there seems to be room for improvement in at least two directions.

[2] *Jour. Amer. Med. Assn.*, Chicago, 1921, lxxvii, 531.
[3] Cowdry (E. V.), *Anat. Record*, Phila., 1920, xx, 52.

The Japanese have outdone the Germans in the domination of the lecture method and have failed to compensate for so doing by giving elective courses and by making the curriculum elastic. For example, in thirteen representative medical colleges, lectures consume on an average of 59.67 per cent. of all the time allotted to the teaching of anatomy.[4] In one case they take up as much as 90 per cent. Since approximately the same proportion of lectures is given in other subjects, it is fairly obvious that the students have but little opportunity to discover things for themselves and to develop originality. The rigidity of the curriculum and the absence of any elective courses worthy of the name tend in the same way to stifle individual initiative. On the other hand, it can not be denied that students do learn the principles of medicine in a thorough if cut-and-dried fashion and that they profit greatly by their experience in other ways.

Only one Japanese instructor has volunteered the information (quite unsolicited) that Chinese students are in some cases unfairly treated. The accusation usually comes from foreigners, who know nothing first-hand, or from Chinese, who have also studied in the United States or in Europe. As a matter of fact, Chinese students are probably treated with indifference, or with a shade of patronage, which they may easily resent when they notice how different it is in the United States, where the instructors are particularly interested in them and vie with each other in their efforts to bring out their best qualities, so that, in effect, they receive preferential treatment. I have received verbal confirmation of the statement made in the report of the China Medical Commission of the Rockefeller Foundation[5] that entrance requirements are reduced in the case of Chinese students. This probably does not apply to the Imperial Universities. Actually, it is an encouragement to Chinese students to take up the study of medicine, though the motive may have been to increase the number of students for political or financial reasons.

It is perhaps safe to assume that these young Chinese, like many of their Japanese teachers, come to believe that Western supremacy depends upon nothing more than skill in mechanical inventions. This interpretation is soothing to their feelings, which are sometimes ruffled by the apparent crudity of Western customs. The more thoughtful among them may notice how thoroughly the Chinese classics are studied throughout the Empire and what excellent libraries are to be found in Tokyo, almost rivaling those in

[4] Cowdry (E. V.), *Anat Record*, Phila., 1920, xviii, 84.

[5] Rockefeller Foundation, 1914, Report of the China Medical Commission on Medicine in China. University of Chicago Press, 113 pp.

Peking, as compared with the easy way in which the classics are dismissed from consideration in the occident. As they follow the successive steps in Japan's renaissance, they cannot help observing that it is quite possible to take advantage of Western discoveries without jeopardizing the fundamental ideals of oriental civilization. Far from being injured by the new teaching Shinto and Buddhist shrines receive financial support from the Imperial Department of Education and are gradually increasing in number. Whether this increase is commensurate with the increase in population, I am unable to say, but even a casual visitor will notice how carefully the temples are tended in comparison with the dilapidated and neglected appearance of national monuments in China. They note also that the Japanese have overcome their scruples and have organized a system for obtaining bodies for dissection, which is unique in its efficiency. During the year 1914-15 over one thousand bodies were available at the Tokyo Imperial University alone; about ten times the yearly supply for the whole of China.

BODIES DISSECTED IN THE JAPANESE IMPERIAL UNIVERSITIES

YEAR	TOKYO	KYOTO	TOHOKU	KYUSHU
1917-18	781	370	223	378
1916-17	939	416	173	396
1915-16	724	435	93	438
1914-15	1,328	427	94	330
1913-14	888	433	89	329

The atmosphere in which the students live is charged with a strange mixture of liberalism and autocracy. Surprising innovations are being made, some of which are almost without parallel, even in the United States. The real significance of the enforcement of a law, passed some years ago, according to which the Presidents of the Imperial Universities of Tokyo and Kyoto are appointed on the recommendation of a nominating committee elected by the faculty, instead of by the Emperor, probably escapes them; but they do observe that freedom of speech is increasing and that the voting franchise is being extended. Growing confidence in the democratic methods of private schools is exemplified by the President of the Kyoto Imperial University sending his son to the Keioh University in preference to a government institution, an action which caused lively discussion and comment. The liberal and progressive element is certainly gaining strength in all domestic affairs, but unfortunately it is still quite inconspicuous in the foreign policy pursued by the government in Korea and in China. Both at home and abroad these students have had a taste of the shady side of militarism so that many of them become intensely liberal in their sympathies. With their pride of race they feel, and

are justified in feeling, that what Japan has done they can also do. As far as they are able, they will try to duplicate her successes and to avoid the painfully mistaken Prussian philosophy of her military leaders. On their return to China, many of them secure positions of responsibility and exercise considerable influence (often political) in the federal and provincial medical schools and hospitals. It is natural for them to send their own students to Japan, to buy their medical supplies in the Japanese markets with which they are familiar, and, in some cases, to appoint skilled Japanese instructors to important posts in which other foreigners would not be tolerated. Only recently, following the Shantung award, has it become necessary to replace these Japanese by Chinese in the medical schools of the capital.

Professor John Dewey[6] sums up the situation as follows: "Although cultivated Japanese as well as politicians like Marquis Okuma have long proclaimed the right and duty of Japan to lead China, to be the mediator in introducing western culture into Asia (including India, where they look upon the English[7] as alien interlopers), few Americans have taken seriously the dependence of China upon Japan in just these ways. I have seen books on the development of modern Chinese education which do not mention Japan, which attribute the renovation of the Chinese system to American influence, and which leave the impression that it is molded upon the American common school system. As a matter of fact, it is molded administratively wholly after the Japanese system, which, so far as Western influence enters in, is based on the German system, with factors borrowed from French centralization. I have visited nine provinces and seen the educational leaders in the capitals where the higher schools are concentrated. There are but two cities, Peking and Nanking, where, in the government schools, direct western influence begins to approach the Japanese, either in methods or personnel. To talk about returned students and fail to discriminate between those from Japan and those from Europe and America is to confuse everything touched by the discussion." He goes on to say that "By far the greater number of the revolutionary leaders who formed the Republic were Japanese or had lived in Japan as refugees and imbibed its culture as they never assimilated that of the West."

Japanese Teaching In China

In addition to training Chinese students at home, the Japanese

[6] *The Asia Magazine*, 1921, xxi, 582.

[7] In this, the Japanese are deceiving themselves, because anthropologists hold that the English are Aryan and consequently more closely related to the Hindus (who are also Aryan) than are the Japanese.

are actively carrying medical education into China. In 1911 the South Manchuria Railway Company established a good hospital and medical school at Mukden. The arrangement of buildings is illustrated on page 290. Visitors are ushered into a reception room and, after a fitting delay, are received by the director who conducts them on a tour of inspection. On entering the wards, which extend out behind the main hospital building and are spotlessly clean, dispensation is courteously granted so that it is not necessary to follow the Japanese custom and remove one's shoes. Any dirt that may have been introduced is quietly wiped away by nurses wearing their black and heavily-oiled hair piled high in pompadour, precisely as in Tokyo. Passing from building to building, along paths bordered with newly planted trees, one is impressed with the completeness of it all. No necessary detail of equipment or administration seems to have been forgotten. The new laboratory building, shown on page 291, would not seem out of place on the campus of one of our best universities. It is semi-fireproof and the rooms are laid out upon the unit system and supplied with moveable furniture so that they may be easily adapted to meet the changing demands of medical science.

Useful information is given in the official announcement, printed in English (for the convenience of foreigners), from which I quote *verbatim* as follows:

AIMS OF COLLEGE

The aims of the college lie in training Japanese and Chinese physicians of fine character and competent ability who assume their parts to contribute to the progress of medical science, particularly to study the natures of, and the cures for, endemics peculiar to Manchuria.

STATUS OF COLLEGE

The college stands on a plane equal to the medical colleges at home under government management. It is organized according to the Imperial College Act. It goes without saying that the graduates of this college are entitled to every privilege and qualification accorded to the graduates of home colleges.

COMPETITIVE ENTRANCE EXAMINATION

The competitive entrance examination for the first year grade of the principal course is conducted in:

Mathematics (algebra, geometry and trigonometry), physics, chemistry, natural history (zoology, botany, physiology and hygiene), composition, foreign language (either English or German), Japanese (for Chinese applicants only), etc.

The standard of the examination is put on a level similar to that of a graduate of a middle school.

The entrance examination for the first grade of the preparatory course is held in mathematics (arithmetic and algebra), physics, geography, and history, Chinese classics, drawing, etc., on a level with the third year of the middle school.

CURRICULUM

The new students joining the first year grade of the preparatory course

are to take up the study of ethics, Chinese classics, Japanese, mathematics, physics, chemistry, biology, gymnastic exercises, etc., in the course of two years, and then pass into the first grade of the principal course.

The curriculum of the principal course running four years comprises: Physics, chemistry, anatomy, physiology, pathology, pharmacology, interclinique, surgery, kinderclinique, dermatology, the science and treatment of venereal diseases, rhyno-laryngo-otology, opthalmology, gynecology, psychology, hygiene, bacteriology, medical jurisprudence, dentistry and oral surgery, ethics, Chinese or Japanese (Chinese for the Japanese students and Japanese for the Chinese), German, gymnastic exercises, etc.

Monthly Expenses of Students

The monthly expenses of a student inclusive of tuition fee, dormitory expenses, etc., amount about Y 17 each.

I am indebted to Doctor Motoi Yamada, Director of the college at the time of my first visit, for many courtesies and to his successor, Doctor M. Hirano, for the following detailed information which shows a steady increase in the proportion of Chinese students compared with Japanese, and enables us to calculate the cost of the education provided. In 1921 the outlay for current expenses exceeds the income by 394,773 Yen, so that each of the 212 students represents a yearly expenditure of 1,862 Yen or about $931 U. S., which compares favorably with the tuition fee of 17 Yen per month (including dormitory and other expenses). On the basis of ten months' instruction per year, this would amount to 170 Yen, or about $85 U. S.:[8]

Annual Budget of 1921

	(School)	(Hospital)
Buildings, gold yen	186,912	314,348
Instruments	5,400	9,000
Books	8,100	———
Income	6,472	434,574
Current Expenses:		
Outlay	278,703	557,116

Students

	(Japanese)	(Chinese)	(Total)
Final class	18	13	31
Fourth class	25	15	40
Third class	19	17	36
Second class	28	16	44
First class	37	14	61
Total	127	85	212

[8] The Report of the Council on Medical Education and Hospitals (*Jour. Amer. Med. Assn.*, Chicago, 1921, lxxvii, 534) for the year 1920-1921 shows that in 42 American medical schools listed in Class A, the fees for each student range from $175 to $350 per year, which does not include the very large item of living expenses.

GRADUATES

(No.)	(Year)	(Japanese)	(Chinese)	(Total)
1st	1915	11	0	11
2nd	1916	12	0	12
3rd	1917	17	4	21
4th	1918	24	11	35
5th	1919	24	14	38
6th	1920	25	15	40
Total		113	44	157

BODIES FOR ANATOMICAL PURPOSES

(Year)	(Men)	(Women)	(Total)
1911	3	2	5
1912	18	5	23
1913	31	7	38
1914	44	10	54
1915	120	21	141
1916	88	15	103
1917	65	14	79
1918	56	14	70
1919	34	10	44
1920	71	12	83

PATIENTS

(Year)	(Outpatients)	(Inpatients)	(Total)
1911	23,543	13,884	37,427
1912	35,890	20,000	55,890
1913	62,035	34,701	96,736
1914	68,911	49,628	118,539
1915	69,536	67,257	136,793
1916	84,839	70,507	155,346
1917	114,423	75,888	190,311
1918	116,135	74,847	190,982
1919	126,033	83,417	209,450

A beautiful booklet, bound in yellow silk, containing a splendid selection of photographs of the buildings, clinics and points of interest, has been recently published and may be obtained from the director. In the pre-clinical divisions there is an adequate full-time staff, so that the college is able to distribute every year a most creditable volume of reprints of scientific contributions. An important innovation is made with respect to travel. Entire classes of students have visited our college in Peking and make other expeditions in order to become familiar with local conditions.

The Chinese students at Mukden appear to be treated on a basis of absolute equality with their Japanese companions; whereas, in the Japanese Government School at Seoul (Keijo Medical School), a special and more advanced course is provided for the Japanese which gives them certain privileges not enjoyed by the Koreans. The two courses are clearly set forth in the yearly Japanese an-

nouncement.[9] In practical gross anatomy, for instance, the Japanese are given 144 hours and the Koreans only 36. No harmful results of the present régime are noticeable, probably for the reason that a missionary institution, the Severance Union Medical College, gives excellent medical training to classes chiefly composed of Koreans which compensates so that highly trained Koreans, as well as Japanese, enter medical practice.

The Japanese Government maintains a medical school in Formosa, which admits Chinese students, and is reported to be in good condition. The Japanese military authorities have closed the former German Medical School at Tsingtau, though the hospital is said to be open. I am told[10] that Professor M. Miyajima, of the Kitasato Institute of Infectious Disease, has recently visited Shanghai in order to report on the advisability of opening there a branch of the Institute. Such action would meet a need which has long been felt for sera of different kinds.

A Japanese society, of which the late Marquis Okuma was president, operates a system of hospitals in the larger cities, such as Peking, Nanking, Shanghai, etc., and a new one is now under construction at Hankow. The entrance to the Dojin Hospital of this society in Peking is shown on page 292. The style of architecture is very characteristic of Japanese buildings in China. While these hospitals are intended primarily for Japanese residents, and occasionally afford asylum to Chinese political refugees, they do take in number of Chinese patients and serve as active centers for the dissemination of ideas of western medicine. The cures which are effected lead the people to doubt the efficacy of native Chinese medicine which is a stride in the right direction for dissatisfaction with present conditions is the strongest motive for improvement.

Japanese drug stores are widely scattered in many towns throughout China. The drugs are not of the best and morphine is often sold in disguise, as has been shown in a careful survey undertaken by the "Peking and Tientsin Times" in 1920. But we recall that other nations hold no monopoly of virtue with respect to either opium or patent medicines. The drugs dispensed in these stores at considerable profit are, at least, improvements on native Chinese remedies which are often made up on the principle that they must be as disgusting as possible in order to frighten away the evil spirits which cause the disease. The stores will continue to be little clinics where informal advice is given regarding minor ailments. Good business demands that the proprietors attempt to give

[9] I am indebted to Dr. E. T. Hsieh for a translation.

[10] By Professor Hiroshi Ohshima of the Kyushu Imperial University.

satisfaction to their customers and not impose upon them to the point of losing their patronage. "A little medicine is a dangerous thing" where it leads to ignoring the valuable advice of competent physicians; but, in China, where there are so few physicians, a little western medicine is certainly better than none at all. It is, at least, a competitor in a small way, and weakens the monopoly of native medicine, which, with its large elements of fancy and superstition, exercises, in my opinion, a strong inhibiting influence upon independence of thought and action.

In times of plague and famine, the Japanese are always among the first to come forward to help. Just at present there is a tendency to disparage their efforts and to look for hidden motives which may not exist. When they contribute to famine relief, it is called propaganda; when they erect a new hospital, it is also called propaganda, leading, it is said, directly to disarming opposition and to making the penetration and eventual control of China easier. Every action in which a selfish motive cannot be immediately seen is labeled in the same way, and they are not slow to return the compliment by suspecting the actions of other foreign nations. There can be no doubt that many Japanese regard the expenditures of the Rockefeller Foundation in China as propaganda pure and simple. An aphorism of the Chinese philosopher, Lao Tzû[11] is *à propos*: "He who has not faith in others shall find no faith in them." This mistrust is lamentable because it makes cooperation so very difficult. As a matter of fact, the absence of organized Japanese propaganda in China with attractive concessions aiming at the establishment and maintenance of cordial relations is most noticeable.

Japanese help comes in a perfectly natural and straightforward way. The Chinese Army Medical School in Peking may be in part regarded as an outcome of the repeated demonstration by the Japanese in North China of the practical value of a really efficient army medical service. Regimental surgeons in the south of China are trained at the Kwangtung Provincial Medical School at Canton, which is below par in both equipment and personnel. During hostilities, officers from the headquarters of the Chinese Red Cross in Peking are occasionally supplied to the southern troops.

Japanese settlements in the treaty ports and elsewhere are, as one would expect, growing much more rapidly than those of other nations. The in-coming Japanese bring with them improved methods of sanitation and for the care of the sick which they place

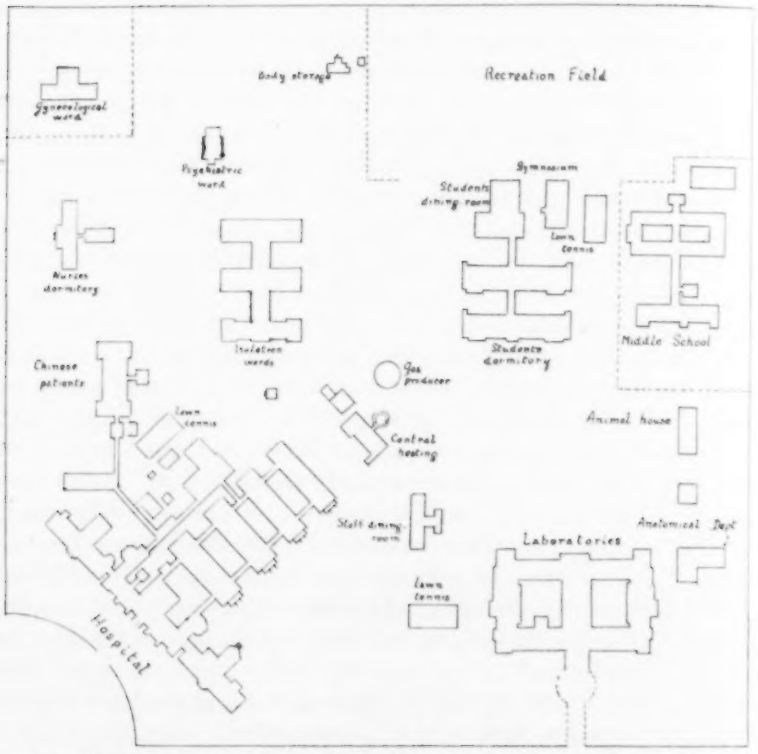
[11] Giles (Lionel), The Sayings of Lao Tzu. London, John Murray, 1917, 53 pp.

at the disposal of the Chinese at a price which the Chinese are usually well able to pay. It is not at all a question of charity, which the Chinese find it so difficult to understand. Their schools and hospitals in China, like those of the Chinese Government, are absolutely free from religious teaching. Conversion to Shintoism is not even a desideratum. The Japanese have numerous temples in China which can be recognized by the peculiar arches, called tori, at their entrances, but there is no attempt to demonstrate, or even to suggest, the superiority of the form of Buddhism which they profess. It is, I think, safe to say that without the tremendous force and inspiration of the missionary motive the Japanese have, indirectly and without any spirit of altruism, accomplished more in the introduction of modern medicine than any other nation. Certainly the results obtained by the non-missionary organizations of any country (except perhaps the United States) do not bear comparison with those of the Japanese. Of the thirteen medical schools under foreign control (not counting Japanese), eleven are under missionary auspices, the Medical Department of Hongkong University is a Government Institution and the Peking Union Medical College is "sympathetic with the missionary spirit and motive" with six of its thirteen trustees appointed by missionary societies.

It is to be hoped that the Japanese will adopt the plan of offering scholarships or prizes to Chinese students to enable them to study in Japan. To be most effective, these scholarships should come from the Imperial Japanese Department of Education in cooperation with the Foreign Office but commercial organizations trading in China are in a position to help. If, for instance, some of the large firms dealing in medical supplies, comparable to Burrows Wellcome & Co., in England, should offer a scholarship to the student graduating at the head of his class in each of the Chinese provincial medical schools enabling him to study for a year in a Japanese Imperial University, it would establish cordial relations and the firm would certainly not be the loser in the long run. This might pave the way for the establishment of a system of exchange professorships between Japanese and Chinese Universities. If the Japanese will only coordinate and systematize their influence in the introduction of modern medicine into China, important results will surely follow for their opportunity is unique.

Japan's Qualifications as Teacher

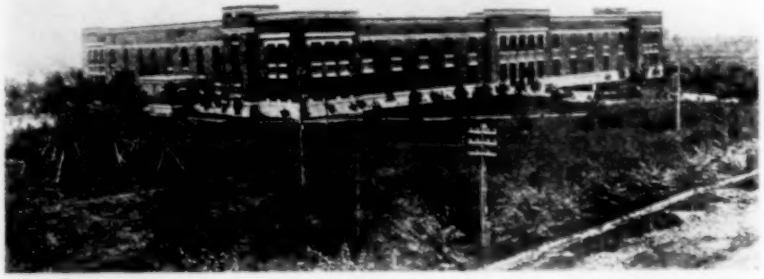
European nations can help China but the help is as nothing compared with what the Japanese are capable of giving. They



PLAN OF ARRANGEMENT OF BUILDINGS OF THE SOUTH MANCHURIAN RAILWAY MEDICAL SCHOOL, MUKDEN

have almost accomplished the task which China is beginning. Seventy-five years ago, the same kind of native medicine was powerful in Japan. With the aid of their strongly centralized government, they have rigorously attacked it and have almost banished it from the Empire so that the casual visitor has to look carefully indeed to find any traces remaining. The picturesque priest-doctors of Old Japan, illustrated so well in a recent number of the "National Geographic Magazine," are seldom seen. The old Chinese pharmacopœia with its noisome preparations has been cast aside; and acupuncture, or the art of healing by relieving the body of the malicious excess of male or female principles through needle-sticking, has been made unpopular. An intellectual revolution has, in fact, been accomplished. Thanks also to the circumstance that the Japanese have borrowed their writing and their culture from China, it is relatively easy for them to make themselves at home and to understand local conditions. It is fashionable now-a-days to harp on racial differences, but in Peking Cantonese are sometimes mistaken for Japanese; and, when I visited

the Tokyo Imperial University with a Japanese friend who out of politeness to me spoke English, he was at first mistaken by his fellow-countrymen for a Chinese. Similarity of this kind is of course exceptional, but it is none the less significant. Nobody would long mistake a European for a Chinese. And, lastly, the Japanese have the advantage of propinquity. With the establishment of a new line of fast steamers between Shanghai and Nagasaki, reducing the time of passage to less than thirty six hours, travel will be greatly expedited. Close estimates show that it costs less than one tenth as much for Chinese students to obtain a good medical education in Japan as it does in the United States. Under these circumstances it is not surprising that some of the provincial governments send more students to Japan than do all the rest of



NEW LABORATORY BUILDING OF THE SOUTH MANCHURIAN RAILWAY MEDICAL SCHOOL DEVOTED CHIEFLY TO INSTRUCTION AND RESEARCH IN THE PRECLINICAL SCIENCES

the world put together. I am informed[12] that the Province of Chekiang maintains approximately thirty students of different kinds in Europe and America as compared with about one hundred in Japan. Students who have to save up and pay their own way find the low traveling expenses and simple scale of living in Japan very attractive.

Though I agree with the late Marquis Okuma that it is the right and duty of Japan to aid China, I do not for a moment advocate anything approaching a monopoly in this respect; for if the help of other foreign powers are withdrawn, or pursued with less vigor, it would be a very real catastrophe. Japan's contribution can be made of great value in spite of the fact that she is naturally unable

[12] Dr. Tsang G. Ni of the Hangchow Provincial Medical School, Hangchow, Chekiang.

to compete on an equal footing with Western nations in the introduction of western culture and philosophy. She gives what she has herself absorbed in the manifold applications of science to human welfare; but China is such an immense country that there is ample room for all the assistance that can be rendered. The goal is still afar off. As a matter of fact, hardly a beginning has yet been made since the large rural population remains untouched. We have to guard against misplaced optimism. China's traditional inertia will probably prevent the change from spreading over the nation with lightning-like rapidity as in Japan. A stable and united government is one prerequisite and Japan can help as none other to this end if she so desires. The calling of the Arms

ENTRANCE TO THE DOJIN HOSPITAL, PEKING

Conference in Washington is in reality a challenge to the liberal party in Japan to arise and throw off part of the burden of armaments, to refrain from military aggression and political intrigue in China and to lead other nations in a constructive program which will eventually place China in a position to help herself and to contribute her share toward "the welfare of mankind throughout the world."

The way is plain—all that is needed to extend Japanese influence is to put in practice a sufficiently comprehensive and well thought out program in which cooperation is the key-word. It is, after all, a problem in racial psychology. During many cen-

turies China has been the intellectual master of Japan.[13] Now a rather delicate adjustment is required in the mental attitude of the new teacher as well as the old master. Japan's great success in adapting herself to the outside world, and the outcome of an unequal struggle with Russia, has bred arrogance, but I am one of those who believe that when she adopts a conciliatory and helpful attitude, China will meet her more than half way. Certain it is that the great masses of China's vast agricultural population have not yet awakened even to a realization of their wrongs. They toil on in philosophic calm and regard all foreigners with indifference. Much depends upon the spirit in which they, through education, slowly come to develop coherence and national ideals. In this, also, Japan will play a leading rôle.

[13] Fujikawa's Geschichte der Medzin in Japan (Tokyo, 1911) is replete with references to Chinese influence in the introduction of medicine into Japan, particularly during the Tang and Ming dynasties. Not only was medicine introduced by travelers and priest-doctors but the Japanese government sent special students to China to study medicine as early as 608 A. D. Not until the coming of Europeans did Chinese influence begin to wane.

A CURIOUS MATHEMATICAL TITLE-PAGE

By Professor F. CAJORI
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"CIRCLES to square and cubes to double would give a man excessive trouble." Thus sings old Matthew Prior, indicating that "many knotty points there are, which all discuss but few can clear." Indeed, hundreds of would-be pathfinders of the intellect, from the time of Anaxagoras down to ours, have gone into ecstasy in the belief that they had solved the impossible problem of the squaring of the circle, only perhaps later to be cast into the depths of disappointment upon learning of their failure. Many have died under the delusion that they had accomplished the impossible.

The problem of the quadrature of the circle presents a strange phenomenon in the history of thought. A geometric construction is to be effected on very definite assumptions and restrictions—the use of a pair of compasses and an ungraduated ruler.

One element of strangeness lies in the fact that the problem has no bearing whatever on practical life. The mathematician and engineer can compute the area of a circle to any desired degree of approximation; if they wish, they can carry approximations to hundreds of decimal places, although five or six places suffice in practice.

Another feature constitutes a source of pride to present-day mathematicians. Unlike some philosophical questions which are as far from solution now as they were aeons ago, the circle-problem, after thousands of years of intellectual effort, has been finally and definitely conquered; in 1882 it was proved by conclusive demonstration accepted by all trained mathematicians, that, under the restrictions imposed, the circle can not be squared.

One item of interest, in connection with the quadrature of the circle, is not generally known. The problem suggested an illustrated title-page which is perhaps the most unique that has ever adorned a mathematical book. In 1647 the Flemish Jesuit mathematician, Gregory St. Vincent, published a wonderful geometry, containing genuine pearls of new geometric truth, but unfortunately also a false diamond, the quadrature of the circle. We reproduce the title-page, which presents to the eye the nature of

For this photograph I am indebted to Professor H. Bosmans, S. J., of Brussels.

THE ENGRAVED TITLE PAGE OF GREGORY ST. VINCENT'S *QUADRATURA CIRCULI*, ANTWERP, 1647

our obstruse problem. Seldom has a subtle abstract question found such striking concrete illustration. In the fore-ground are three bearded men in old-time garb. One of them with staff in hand has just drawn upon the ground, a circle and an equivalent triangle. On the right, the sphere and the cube suggest among other things the accomplished cubature of the sphere. As if these two drawings were not sufficient reference to the solution of the great problem, there is shown also the transmutation of the square and circle into each other by the solar beam of light passing through the square opening in a board and forming upon the ground below, a circular illuminated area. *Mutat quadrata rotundis.* One of the cherubs indicates by a pair of compasses that the figure is a circle. Another gives vivid evidence of surprise and delight. We omit descriptions of the twisted and fluted columns and other details, and only point out the challenge which this engraving makes to modern pedagogues, to equal or surpass, if they can, this powerful appeal to the eye.

Recently the present writer experienced a surprise by the discovery that this same title-page (with only very slight changes in unimportant details) was appropriated sixty years later in an edition of the collected works of another noted Jesuit mathematician, Andreas Tacquet. This edition appeared at Antwerp in 1707, some years after the death of Tacquet. Hence this "borrowing" was done by the editors and publishers. Evidently the novelty and impressiveness of the picture appealed to them so strongly that they used it in Tacquet's works even though this mathematician is not associated with the problem of squaring the circle. Tacquet is known chiefly as a teacher and as the editor of an edition of *Euclid* which was translated into English and used in Great Britain as a school book for the larger part of a century. The title-page of the 1707 publication represents therefore the transfer of a fanciful portal originally opening into the mystic realm of transcendental mathematics, to a well-trodden avenue leading to elementary schools.

THE PROGRESS OF SCIENCE[1]

ECLIPSES AND THE EINSTEIN THEORY

EINSTEIN will be the moving spirit behind two expeditions that will spend six months or more traveling to Australia this year to have the opportunity of observing the eclipsed sun for six minutes.

May 29, 1919, when the moon last obscured the whole of the sun, photographs taken by British astronomers off the west coast of Africa and in northern Brazil showed a shift of the images of stars that has, in less than three years, shifted the thoughts of even unscientific people to the Einstein theory of relativity. September 20 of this year is the date on which Einstein's theory can again be put to the test of actual observation.

In an arid country, whose principal vegetation is a prickly plant that will penetrate even fairly thick leggings, a party of American astronomers, headed by Professor W. W. Campbell, director of the Lick Observatory, will set up an observatory. This site will be in northwestern Australia on a desolate coast, but to compensate for the bleakness of the place and hardship of the journey there, it is expected that the American astronomers will have the clearest skies through which to photograph the stars visible due to the eclipse. An Australian warship will carry the party from Sydney to the temporary observatory site. Close at hand there is a telegraph station, Wollal, which will keep the expedition in touch with the outside world.

But the British, whose expeditions secured the photographs of the 1919 eclipse, are going to compete with the Americans in observing. South of Java, 250 miles, on Christmas Island, they will erect their telescope, and they, too, are hoping for fair weather, with cloudless skies, so that they will settle to the satisfaction of all physicists and astronomers whether or not the sun attracts the star light passing by it.

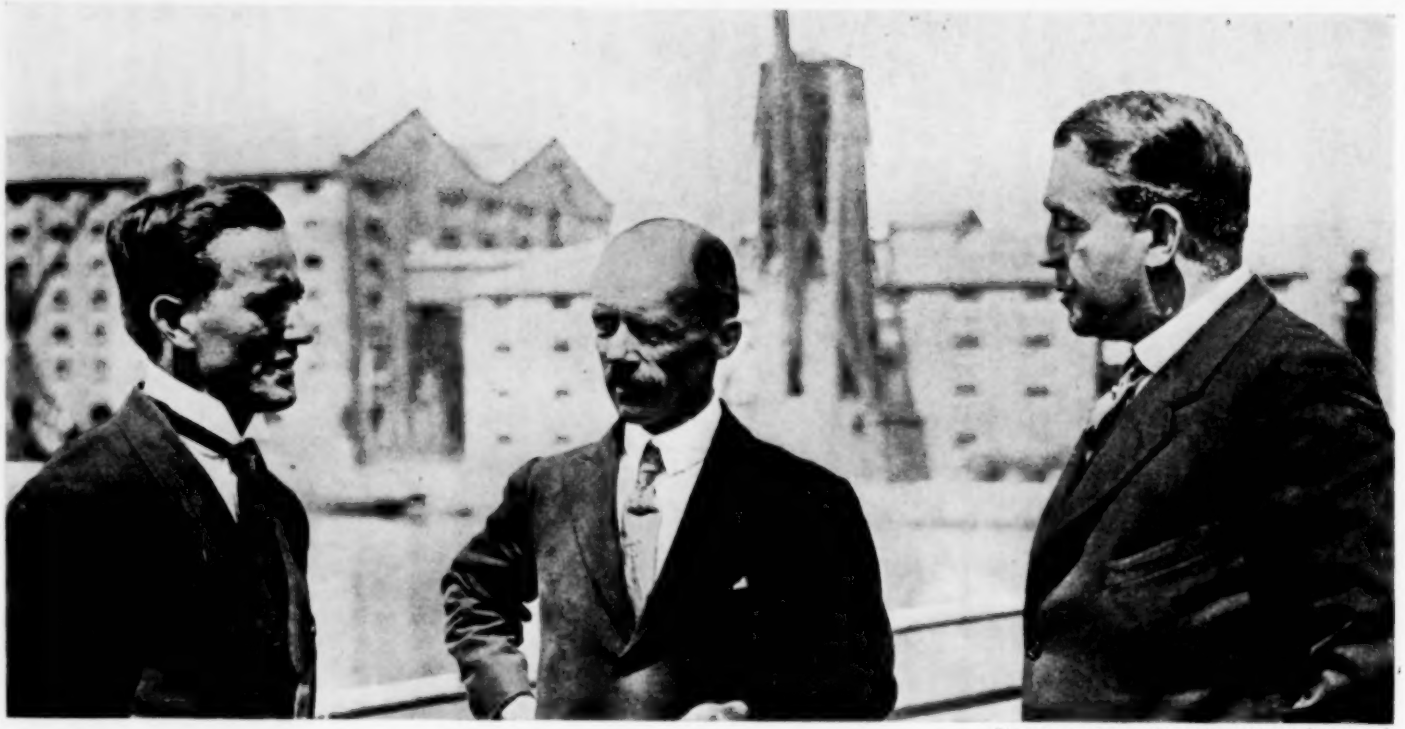
If chance and the elements do not cooperate with the astronomers this fall, it will mean only a postponement of the day of judgment for Einstein's theory. There are more total solar eclipses coming. Including the one this year, there are three in the next three years.

Nearly a year later, September 10, 1923, San Diego will be the objective of astronomical expeditions or there will be telescopes set up in western Mexico. The time that the telescopes can be in action is only about half of that of this year's eclipse, as the totality will be only three and a half minutes, at about mid-day.

The further in the future the eclipses are, the less favorable they are astronomically but the closer they come to the eastern part of the United States. On January 25, 1925, New Yorkers will see the sun extinguished shortly after it rises, and a number of large observatories will have a chance to observe a total eclipse at home without the necessity of a special expedition. The weather conditions of this eclipse are expected to be the poorest of the three.

After this time, if the evidence for or against Einstein is not sufficient, the world must wait until the next eclipse, August 31, 1932, unless by means of photographic plates, sensitized to blue light only, the powerful yellow light of the sun can be ignored

[1] Edited by Watson Davis, Science Service.



Photograph supplied by Underwood and Underwood.

THE LATE SIR ERNEST SHACKLETON AND TWO MEMBERS OF HIS PARTY

Sir Ernest Shackleton, who died from heart disease on January 5, shown at the right, is in conversation with Captain Wilde of *The Quest* and Edal Erikson, a Norwegian member of the expedition. The photograph was taken on *The Quest*, at Southampton, England, shortly before its departure for the South Polar regions.

ABOARD *THE CARNEGIE*, JANUARY 16, 1922
To the left are Captain J. P. Ault, of *The Carnegie*, and Mr. Colin, Captain Frölich Haussen and Mr. Steen, members of the Norwegian Legation. To the right are Captain Roald Amundsen and Dr. Louis A. Bauer.

and the very blue light of some stars can be made to record itself on the special plates in spite of the sun. That is a possibility, in view of the progress of photography.

Since the velocity of light is a leading factor in the Einstein theory, it is now the subject of experiment by astronomers and physicists. The question whether blue or yellow light has the greater velocity has been answered. Probably varying wave-lengths of light have the same velocity. The chances are five to one that the difference in the time of passage of blue light and yellow light through empty space is less than one second in three hundred years. This is the conclusion that has been announced by Dr. Harlow Shapley of the Harvard Observatory after a study of light from the remote globular star cluster, called Messier 5, whose light takes 40,000 years to reach us.

Interest in Einstein has not waned since he came into general notice in 1919 or since his visit to this country in April of last year. The latest Einstein book is not an explanation of his theory, but a book about Einstein himself, "Einstein, the Searcher," a translation from Alexander Moszkowski, a friend and admirer.

EXPEDITIONS TO THE POLES AND THE TROPICS

ALTHOUGH the two poles have been conquered, the frigid zones still attract the typical explorer who goes to unknown parts of the globe to make additions to scientific knowledge.

Last September, Sir Ernest Shackleton and a little party on

Photographed, January 16, by Dr. Louis A. Bauer.

CAPTAIN ROALD AMUNDSEN
On board *The Carnegie* wintering in the Potomac River. Though the day was cold Captain Amundsen made a flying trip from New York unencumbered by an overcoat.

board the *Quest* started south to spend several years on a voyage around the coast line of the Antarctic continent. He planned to bring back scientific data on the magnetism, biology, oceanography, geology and meteorology of that region. Now news comes that Shackleton is dead, even before he began the real work of the trip that he planned as his "swan song." But his expedition will continue.

In Baffin Land at a place called Nauwatta, Dr. D. B. MacMillan and his expedition are wintering. They are busy making observations of magnetic, atmospheric-electric and auroral effects. They are in the land of mysterious polar lights, whose shooting rays dance in rhythm with the quivering magnetic needle. With the cooperation of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, Dr. Louis A. Baner, director, special photographic instruments were carried into the polar regions for the first time. These should give data which will determine whether the aurora borealis comes close to the earth or whether it penetrates no deeper than sixty miles into the earth's atmosphere as Norwegian tests seem to indicate. Unexplored lakes in the interior of Baffin Land will probably be accurately placed on the map by Dr. MacMillan.

About June 1, Captain Roald Amundsen, the Norwegian explorer who discovered the South Pole, will set out from Seattle to make another attempt at drifting across the Arctic Sea frozen in the ice. Aboard the *Maud* will be instruments for determining the magnetism and the magnetic-electric effects at the different

parts of the Arctic that the ship will visit. Soundings of the sea and meteorological observations will also be made. There will be little leisure for Dr. H. U. Sverdrup, who will have charge of the scientific work of the expedition. It is rumored that Captain Amundsen, in addition to his interest in the scientific work, has a natural desire to be the first man to visit both ends of the earth.

While the coldest regions are being discovered and charted, there are also scientific men who will contend with the heat and life of the tropics. This spring the Carnegie Institution is again sending parties headed by Dr. Sylvanus G. Morley and Dr. C. E. Guthe into the ancient country of the Maya to learn the details of their ancient civilization. The Field Museum of Natural History at Chicago has announced that there will be six expeditions that will leave for the tropics before the summer is well under way, to be in the field from two to five years. Two geological parties will visit the area from Brazil to Patagonia. The Isthmus of Panama and the state of Colombia will be visited by an archeological expedition and another party will go to the Malay Peninsula to study the ethnology of that region. Peru will be searched by two expeditions, one zoological and the other botanical.

THE CONCILIUM BIBLIOGRAPHICUM

So fast and broad has been the progress of science during the last few decades that the all-around scientific man no longer exists. All that an earnest worker in science can hope to do is to keep fairly well informed in the small corner of the field of science that he has selected. But to keep complete track of the researches in a single subdivision of science is perhaps an even larger task than following a number of matters in a general way.

Contributions to science are being made in practically all the countries of the world, reported in their own journals and in their own languages. The average student has access to only the limited library of his own college or institution. Few are so situated that they can see the bulk of the periodical literature even in their own field or have easy access to many new books.

Speaking in commercial terms, trade associations of science are needed. So are proper sales organizations and publicity departments, but that is another story. The point has been reached when the distribution of scientific knowledge among research factories is, because of the possibilities for the elimination of waste, an important enterprise for the progress of science itself. Production of science requires its proper distribution.

The re-establishment on a firm basis of the Concilium Bibliographicum at Zurich, Switzerland, which has just been accomplished, is an important step in improving the channels for the distribution of science. The International Catalogue of Scientific Literature is now officially dead from the prevalent financial disorder. The Royal Society could not take up its work completed only as far as the fateful year of 1914.

A stream of cards, 3x5, the library standard, has begun to flow out of the Concilium Bibliographicum. The contents of periodicals in the fields of zoology, physiology, evolution and anatomy are listed on these cards with title and author. The subject matter is indicated by a number in the elaborate system of classification that has been devised. Students, libraries and others can get just as many or as few of these cards as they wish. They can subscribe to all, or to those referring to one kind of butterfly. There are now subscribers in twenty-three countries, and one third of the total is in America.

The card system has advantages

THE FREER GALLERY

Located on the Mall in Washington, this is the latest of the group of buildings of the Smithsonian Institution. The Freer art collections are now being installed in it.

over the yearly volumes, months or years late, that are the usual forms of bibliographic work. Cards allow wide distribution in a minimum of time. The references of the Concilium are also assembled in book form by years for libraries and others who want them.

The Concilium Bibliographicum is an American institution, in spite of its location. It is a living memorial —which is the best kind—to Dr. Herbert Haviland Field, Harvard graduate and zoologist, who died in April of last year. In 1895, realizing how lack of prompt references hampers research work, he established the Concilium in the scientific center of Zurich. It never paid expenses. Subsidies from friends, then loans, kept it going and producing, until the war, which stopped the whole project. Dr. Field died suddenly while doing his best to re-establish his life's work. His efforts had been hampered by Europe's post-war curse, fluctuating exchange.

The Concilium has now been put on its feet, its obligations paid off, its staff held together and its future assured by grants of the Rockefeller Foundation, given through the National Research Council. Dr. Vernon Kellogg, permanent secretary of the National Research Council, visited Zurich to accomplish the re-establishment. Dr. J. Strohl, of the University of Zurich, a zoologist and an accomplished linguist, now heads the reorganized staff and has thrown himself, heart and soul, into the work. At present the control of the Concilium is in the hands of the Swiss Society of Naturalists and the National Research Council, awaiting the time that a representative international board can take control.

It is planned to expand the field covered by the work of the Concilium to cover other fields of science as soon as conditions permit. The abstracting of important papers is also being considered.

A CORPORATION FOR THE ADVANCEMENT OF PSYCHOLOGY

ALL scientific men are concerned with the advancement of the science

in which they work, but only psychologists are professionally occupied with human conduct and its control. It is consequently becoming that they should make a new departure in the organization of their own work.

It has not hitherto been possible for scientific men to follow scientific research as an independent profession. There is no way of paying for the work that is of the greatest value to society. Some three fourths of those engaged in scientific research in this country are professors who earn their living by teaching; about a tenth are in the government service; others are in museums, botanical gardens and the like. It is only in recent years that a few scientific men have been employed to do scientific work in endowed research institutions and in industrial laboratories.

There scarcely exists at present any method by which a scientific man engaged in research can be paid in accordance with its value or by which the economic proceeds of research can be used for further work. A single advance in the applications of science, such as the Bessemer steel process, the electric motor, or the internal combustion engine, adds billions of dollars to the world's wealth, but the profits go to the millionaire who keeps a private yacht and to the laboring man who rides five miles for five cents. If one tenth of the economic value of scientific research could be reserved to pay the scientific men who do the work in order that they might adequately carry forward other researches, knowledge and its applications to human welfare would increase as never before.

Like the physical and biological sciences, psychology has supplied to society services worth manyfold their cost. But universities are indigent and government is shortsighted. An individual psychologist has no way to collect payment for his work. The services of psychology to the army in quickly sorting recruits into classes in accordance with their intelligence were worth many million of dollars to the nation, but the psychologists who created the tests were not paid, and only charity is now available to pay for the research necessary to improve the tests and to adapt them to business and industry.

The Psychological Corporation, now granted a charter by the State of New York, with the leading psychologists of the country as its directors, is the first business corporation whose objects are the advancement of science and whose profits must be used for scientific research. Its central office is in the Grand Central Terminal, New York City, and branches are in course of establishment in Boston, Washington, Pittsburgh, Chicago, San Francisco and other cities. The scientific work of the corporation will, however, be done in existing laboratories and institutions. The president is J. McKeen Cattell; the vice-presidents are Walter Dill Scott and Lewis M. Terman; the chairman of the board is Edward L. Thorndike, and the directors include James R. Angell, Richard E. Dodge, G. Stanley Hall, C. E. Seashore, E. B. Titchener, R. S. Woodworth, R. M. Yerkes and the other psychologists who have contributed most to the advancement of their science.

The Psychological Corporation plans to maintain adequate standards in applied psychology, to assure opportunities and proper payment to those competent to do the work, and to use all profits for psychological research. Its charter reads:

The objects and powers of this corporation shall be the advancement of psychology and the promotion of the useful applications of psychology. It shall have power to enter into contracts for the execution of psychological work, to render expert service involving the application of psychology to educational, business, administrative and other problems, and to do all other things, not inconsistent with the law under which this corporation is organized, to advance

psychology and to promote its useful applications.

SCIENTIFIC ITEMS

We record with regret the death of Professor Charles Baskerville, director of the Chemical Laboratory of the College of the City of New York; of Dr. Pearce Bailey, the New York neurologist; of Sir William Christie, formr astronomer royal; of Sir German Sims Woodhead, professor of pathology in the University of Cambridge, and of Father Guiseppi Lais, vice-director of the Vatican Observatory.

Sir David Prain is about to retire, under the age rule, from the directorship of the Royal Botanic Gardens, Kew, which he has held since 1905. He will be succeeded by Dr. A. W. Hill, who has been assistant director since 1907. Dr. Hill, before his appointment to Kew, was lecturer in botany in the University of Cambridge, of which he is a graduate.

Dr. Hugh M. Smith, who has been United States commissioner of fisheries since 1913, has tendered his resignation. Mr. Herbert Hoover, secretary of commerce, has written to Dr. Smith: "I believe your service for thirty-six years, rising from the bottom to the top, in one of our great scientific bureaus, is unique in the history of the government. The whole country is under an obligation to you for so long and faithful a service."

Mme. Marie Curie on February 7 was elected a member of the Paris Academy of Medicine. It is the first time a woman has been elected a member of one of the French academies. The committee had presented six names as candidates to succeed the late Edmund Perrier. The five men nominated withdrew their names when they found out that Mme. Curie's name was on the list, and she obtained 64 votes against 15 blanks.

The officers of the Ramsay Memorial Fund announce that the dean and chapter of Westminster have consented that a tablet containing a medallion portrait of Sir William Ramsay should be placed in Westminster Abbey in the place immediately below that occupied by the Hooker tablet. The tablet is being executed by Mr. Charles Hartwell, A.R.A. It is anticipated that the unveiling will take place in October next. At the request of the Ramsay Memorial Committee a commemorative medal of the late Sir William Ramsay has beeen executed by the French sculptor, M. Louis Bottée. The medals will be struck in London when it is known approximately how many copies will be required.

A summer meeting of the American Association for the Advancement of Science will, by recent vote of the executive committee of the council, be held at Salt Lake City from June 22 to 24, in conjunction with the annual meeting of the Pacific Division of the association. Arrangements for the meeting are in charge of Mr. W. W. Sargeant, secretary of the Pacific Division. All members of the association and of the associated societies are invited to be present, and all associated societies are invited to hold sessions. Sections of the association are also invited to hold sessions, but no attempt will be made to have all sections represented on the program of the meeting.